Report 052007/2

PROGRESS REPORT ON QUESTA WASTE ROCK INVESTIGATION: WORKPLANS FOR ROUTINE MONITORING, GEOCHEMICAL AND PHYSICAL CHARACTERIZATION

Prepared for

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PROGRESS REPORT ON QUESTA WASTE ROCK INVESTIGATION: WORKPLANS FOR ROUTINE MONITORING, GEOCHEMICAL AND PHYSICAL CHARACTERIZATION

1 INTRODUCTION

1.1 Background

In July 1998, Molycorp submitted a detailed five-year characterization and monitoring program for the Questa waste rock dumps to the NMED as part of the Discharge Plan DP-1055 (Molycorp, 1998). This five-year program outlines the objectives, work scope and schedule for the characterization and monitoring program.

The waste rock characterization program follows a staged approach. In Phase 1 (lasting 3 years) selected waste rock piles will be characterized, instrumented and monitored. The results of the characterization and monitoring will be used to generate and calibrate models of these dumps for predictive modeling and closure alternatives evaluation. In Phase 2, these results will be used to design and implement a characterization program for the remaining dumps.

Each phase of the characterization program consists of a series of tasks and sub-tasks (Molycorp, 1998). Detailed work plans will be prepared for individual tasks (or sub-tasks) and submitted to the NMED for review and approval.

1.2 Work Tasks Completed

The following work tasks have been completed to date (for a description of the individual work tasks of the Phase 1 program, see Molycorp. 1998):

1.2.1 Task 1.1 Review of Mining History and Dump Composition

The geometry of the various waste rock dumps was determined by comparing topographic maps for pre-mining and current conditions. The estimated depths of waste rock agreed fairly well with those encountered at the nine borehole locations.

A preliminary review of mining history and dump development was completed prior to the Phase 1 drilling program. The results of the drilling program will be compared with the mining records to determine the location and distribution of the various waste rock types.

1.2.2 Task 1.3 Phase 1 Drilling and Sampling Program

Following discussions with NMED and internal review the drilling and instrumentation program was finalized and approved by the NMED in a letter dated July 7, 1999. The final work plan stipulated drilling and instrumentation of nine boreholes in three waste rock dumps (2 in Spring Gulch, 3 in Sugar Shack South, 2 in Sugar Shack West and 2 in Capulin/Goathill).

The drilling and instrumentation of the nine boreholes in the waste rock dumps started on July 29th and was completed on August 4th 1999. The drilling and sampling methods are described in the as-built report submitted to Molycorp (SRK, 1999). A preliminary review and interpretation of the initial characterization of borehole samples (logs of lithology; paste pH and paste conductivity; moisture content) were provided in RGC Report 052007/1 entitled "Interim Report: Questa Waste Rock Pile Drilling, Instrumentation and Characterization Study".

The drilling and sampling of two additional boreholes in natural scar material is scheduled for the first week of October. The drilling and sampling methods will be identical to those in the waste rock piles. As outlined in the work plan, these boreholes will not be instrumented. Results of this field work will be submitted to the NMED at a later time.

1.2.3 Task 1.4 Instrumentation & Monitoring

The field instrumentation was completed as outlined in the work plan and is summarized in the as-built report (SRK 1999). Soil suction/moisture sensors were not installed in the boreholes (as originally proposed) due to anticipated difficulties in achieving a good contact with the rock matrix. Consideration is being given to installing such sensors in deep test pits where the material type and compaction characteristics can be controlled to be representative of the rest of the pile material.

Field monitoring of dump temperature was initiated shortly after installation was completed. Field monitoring of pore gas constituents (oxygen and carbon dioxide) began in mid-September. A preliminary review of these initial monitoring data is provided in Section 2 of this report.

The monitoring program for the first year is outlined in Section 3 of this report.

1.3 Scope of Report

This progress report provides the following items:

- Preliminary Review of Field Data;
- Work Plan for Dump Monitoring;
- Work Plan for Geochemical Testing; and
- Work Plan for Physical Testing.

2 PRELIMINARY REVIEW OF FIELD DATA

2.1 Summary of Sample Description

Waste rock samples were taken at five foot intervals during drilling of the nine boreholes (SRK, 1999). These borehole samples were characterized in the field (lithology, paste pH and paste conductivity) and sub-samples were taken to the lab for determination of the moisture content (SRK, 1999). The results of this field characterization program are discussed in the "Interim Report on the Waste Rock Drilling Program" (RGC Report 052007/1). Table 1 provides a summary of these observations and a preliminary assessment of these data.

Detailed logs of the geological description and geochemical field testing of all samples from the nine boreholes are provided in Appendix A. The physical logs of the various borehole samples (which was completed only after submission of the Interim Report) are summarized in Appendix B.

2.2 Waste Rock Monitoring Data

All nine boreholes were instrumented to measure in-situ temperature and to monitor O_2 and CO_2 in pore gas (SRK, 1999). The first complete round of monitoring was performed on September 16th and 17th 1999, i.e. approximately six weeks after installation work had been completed. The following sections provide a brief review and preliminary assessment of these monitoring data.

2.2.1 Temperature Profiles

The temperature profiles observed in the various boreholes on September 16th and 17th 1999 are shown in Figures 1a and 1b. These temperature profiles were very similar to the initial temperature readings taken shortly after instrumentation was completed in mid-August (typically within 2-3° F) suggesting that the air temperature within the dumps equilibrated very quickly.

The temperature monitoring data can be summarized as follows:

- seven of the nine instrumented waste rock dump locations show internal dump temperatures significantly higher than ambient air temperature (55-60°F); "background" temperatures (< 60°F) were only observed in WRD-1 & 6; the highest temperatures (> 100°F) were observed at WRD-2, 4 & 5;

- dump temperatures typically increase monotonically with depth showing maximum temperatures at or near the base of the dump (or bottom of borehole);

- within a given dump, a temperature gradient tends to develop parallel to the slope with lower temperatures at lower elevations and elevated temperatures at higher elevations (e.g. WRD-3 versus WRD-4 in Sugar Shack South and WRD-6 versus WRD-7 in Sugar Shack West);

- the individual temperature readings do not correlate very well with observed lithology and/or paste pH/conductivity at the monitoring locations;

Table 1. Summary of Field Characterization in Various Boreholes in Waste Rock.

Borehole	Location	Bench Level	Lithology[1]	Field Characterization	Preliminary Interpretation[2]
WRD-1	Spring Gulch	9100'	aplite in upper 25'; black andesite (w/ calcite) in lower portion	high paste pH & moderately low paste cond	predominantly non-acid generating material; significant calcite buffering
WRD-2		9250'	hydrothermally altered mixed volcanics, some aplite at base	very low paste pH & high/very high paste cond	predominantly acid generating material; appears to be significant accumulation of secondary minerals near base
WRD-3	Sugar Shack South	8700'	unaltered andesite & aplite in upper 55'; hydrothermally altered andesite and mixed volcanics in lower portion	high paste pH & moderate paste cond in upper portion; moderate/low paste pH & high paste cond in lower portion	non-acid generating material in upper profile;some acid generating material in lower profile; potentially significant accumulation of secondary minerals near base
WRD-4		9150'	mix of hydrothermally altered mixed volcanics, aplite/granite, and unaltered grey volcanics	moderate paste pH and moderate/high paste cond	mix of acid generating and non-acid generating material; appears to be significant accumulation of secondary minerals near base
WRD-5		9250'	hydrothermally altered mixed volcanics in upper 25'; grey-green andesite (propylitic) in lower portion	low paste pH and moderate paste cond in upper portion; high paste pH and moderate paste cond in lower portion	mix of acid generating and non-acid generating material; calcite buffering in lower profile
WRD-6	Sugar Shack West	9000'	hydrothermally altered mixed volcanics in upper 30'; unaltered tuff in grey-brown matrix at depth	low paste pH and moderate/ high paste cond in upper portion; high paste pH and moderate/ high paste cond in lower portion	potentially acid-generating material throughout; predicted "acid front" at a depth of ~30ft
WRD-7		9400'	hydrothermally altered mixed volcanics (w/ aplite) in upper 30'; hydrothermally altered mixed volcanics (w/ rhyolite) in grey-brown matrix at depth	low paste pH and moderate high paste cond in upper portion; high paste pH and moderate/ low paste cond in lower portion	potentially acid-generating material throughout; predicted "acid front" at a depth of ~30ft
WRD-8	Capulin	9810'	crystal rich grey tuff with altered (grey/light brown) clay matrix	low paste pH and moderate/ high paste cond	acid-generating material throughout; predicted "acid front" at base of pile
WRD-9		9800'	mixed volcanics, tuff and black andesite	low paste pH and moderate/ high paste cond	acid-generating material throughout; predicted "acid front" at base of pile; appears to be significant accumulation of secondary minerals near base

Note:
[1] emphasis placed on weathered matrix (e.g. "hydrothermally altered mixed volcanics" characterized by yellow-brown matrix in field descriptions)
[2] based on preliminary data (needs to be confirmed by geochemical testing and future monitoring)

Ultimately, all heat generated within a dump is caused by the exothermic reaction (oxidation) of sulfide minerals present within the waste rock. However, this does not necessarily imply that the most reactive material (with the highest oxidation rates) is located in areas of the pile with the highest temperatures. In order to understand the temperature at a given point one has to assess not only the oxidation rates of the local material (local heat source), but also the pattern of air movement, the oxidation rates of the waste rock material along the air flow path (upstream heat source), and heat conduction through the waste rock material.

The temperature gradients observed at Questa in most locations are sufficiently strong to create significant advective air movement ("thermal venting") within a coarse waste rock pile. The fact that local dump temperatures appear to be more influenced by dump topography and geometry (depth, distance from toe, etc.) than by local geochemical conditions (lithology, paste pH etc.) supports the hypothesis that advection is a significant transport mechanism.

Note that temperatures within a dump (and advective air movement) may be significantly affected by seasonal changes in the ambient air temperatures. Temperature monitoring in the instrumented dumps will be continued to study these seasonal phenomena (see Section 3.2).

2.2.2 Oxygen Profiles

The oxygen profiles observed on September 16th and 17th 1999 in the various waste rock dumps are shown in Figures 2a and 2b.

The oxygen data can be summarized as follows:

- oxygen concentrations do not show a consistent relationship with depth; some boreholes show a decrease with depth (WRD-5, 6, 8 & 9) while others show an increase with depth (WRD-2 & 7) or no change at all (WRD-1, 3 & 4);

- several boreholes showed no depletion of oxygen (i.e. ambient oxygen concentrations of about ~20%) throughout the dump profile (WRD-1 and WRD-3) or near the base of the waste rock pile (WRD-2 and WRD-9);

- very strong oxygen depletion (<5%) throughout the profile was only observed at WRD-7; some local depletion of oxygen was observed at WRD-2, 5 & 6;

Since completion of this report a second round of pore gas monitoring has been completed (October 21 1999). The pore gas concentrations measured during this most recent survey (not shown here) agree very well with those shown in Figures 2-4. In other words, the measured pore gas concentrations in the boreholes (resulting from oxidation reactions and air flow) appear to have reached equilibrium within six weeks of drilling/installation and likely represent true in-situ conditions.

The monitoring data clearly suggest that the Questa dumps are not "oxygen-limited", i.e. the supply of oxygen does not appear to be a rate-limiting step in the oxidation of sulfide minerals except in a few locations where oxygen approaches zero (e.g. WRD-6).

Furthermore, the oxygen data strongly suggest that advection is the dominant mechanism for transporting oxygen within the Questa dumps. A review of the spatial distribution of oxygen suggests that "fresh air" may enter the dump either along the exposed slope faces (potentially driven into the upper profile by wind action and/or barometric pumping, see for example WRD-8 & 9) or along the coarse basal layer of the pile ("sucked" into the pile by thermal convection, see for example WRD-2 or WRD-9).

The oxygen data collected at the three stations in Sugar Shack South (WRD-3, 4 & 5) indicate a gradual decrease in oxygen content in the pore gas with distance from the toe of the pile. Large-scale thermal convection within this pile could explain this spatial distribution of oxygen (progressive consumption of oxygen in pore gas along the air flow path). The data collected from the three stations in Sugar Shack South provide an excellent opportunity to study the influence of large-scale convection on oxidation of the waste rock material (see Section 2.3).

None of the oxygen profiles show a uniform decrease with depth, which is commonly observed in waste rock dumps which are diffusion-controlled (with the possible exception of WRD-6). The contribution of diffusion to oxygen transport is likely very small at Questa and restricted to the near-surface zone. Oxygen monitoring in the instrumented dumps will be continued to confirm these preliminary findings (see Section 3).

2.2.3 Carbon Dioxide Profiles

The carbon dioxide profiles observed on September 16th and 17th 1999 in the various waste rock dumps are shown in Figures 3a and 3b. A scatter plot of oxygen and carbon dioxide measurements for all monitoring points is shown in Figure 4.

The carbon dioxide data can be summarized as follows:

- carbon dioxide concentrations in pore gas vary from as low as 0.1% (ambient CO_2 concentrations in air, e.g. WRD-1 & 3) to as high as 11% (WRD-6);
- in the majority of locations (WRD-1, 3, 4, 5, 6 & 7) carbon dioxide concentrations are inversely proportional to the oxygen concentration (with an increase in CO_2 of about 2.5% for every 10% decrease in O_2);
- at three locations (WRD-2, 8 & 9) carbon dioxide concentrations are very low despite significant oxygen depletion

As mentioned above for O_2, the CO_2 profiles observed during the latest round of pore gas monitoring (October 21 1999, not shown) were also very similar to those shown in Figure 3 suggesting that the measured CO_2 concentrations are representative of in-situ conditions. Note, however, that some CO_2 readings in WRD-7 are higher than the quoted upper limit of the instrument (i.e. 10%). It is likely that the CO2 readings recorded in the lower portion of WRD-7 are in fact greater than the measured 11%.

Elevated levels of carbon dioxide in pore gas are likely indicative of calcite buffering within the dump. The CO_2 data concur with the preliminary conclusions from the paste pH and conductivity survey that the waste rock material at WRD-2 (upper Spring Gulch), WRD-8 (Capulin Canyon) and WRD-9 (Capulin/Goathill) has very little, if any, neutralizing capacity (at least in the form of calcite).

The fact that most other dumps show a consistent anti-correlation between CO_2 and O_2 (Figure 4) suggest that calcite, or other carbonates, are the dominant neutralizing agent and is common throughout the majority of the dumps.

As outlined earlier in the discussion of dump temperature and oxygen concentrations, the observed carbon dioxide concentrations will need to be interpreted in the context of air flow through the dumps (i.e. CO_2 concentrations may be influenced by the buffering reactions occurring upstream of the monitoring point).

Carbon dioxide monitoring in the instrumented dumps will be continued to confirm these preliminary findings (see Section 3).

2.3 Implications for Future Work

The preliminary review of all field data shows a significant variability among the nine instrumented boreholes, both in terms of geochemical characteristics of the waste rock and the in-situ temperature and O_2/CO_2 concentrations in pore gas. The broad range of conditions encountered in these boreholes provides an excellent opportunity to study the geochemical and physical controls on ARD development at the Questa dumps.

Advective air flow has been identified as the likely dominant transport mechanism for oxygen within the dumps in at least seven of the nine instrumented boreholes (the only possible exceptions are WRD-6 and 7 at Sugar Shack West). Air flow modeling should be carried out in order to assess the relative importance of (i) thermal convection (ii) wind-induced advection and (iii) barometric pumping. A detailed work plan for the air flow modeling will be provided after review of the routine monitoring data collected over a three-month period. The routine monitoring program of dump temperatures and pore gas constituents has been designed to obtain the data required to perform the air flow modeling (see Work Plan for Dump Monitoring in Section 3).

Thermal convection is clearly evident in several "hot piles" (e.g. WRD-2, 4 & 5). Thermal convection does not only influence the supply of oxygen for sulfide oxidation (by "sucking" fresh air potentially deep into the pile). It may also significantly influence the moisture distribution within a pile. The hot air near the base of the pile can potentially result in significant internal drying of the waste rock piles. The water vapour may be carried upward during convection. As the air cools on its way up to the pile surface the water vapour will condense releasing some of the moisture back to the waste rock matrix. In very permeable waste rock layers, so-called chimneys, the air may have little opportunity to cool down and hot moist air may leave the pile producing the observable steaming vents.

In summary, thermal convection may have an important influence on the water balance and thus ARD migration from a waste rock pile (note very high paste conductivities have been observed near the base of most "hot piles" which may indicate evaporative drying of dissolved solids). Provisions have been made in the routine monitoring program to measure the relative humidity at various depths within the piles (see Work Plan for Routine Monitoring in section 3). This data in conjunction with air flow modeling will enable an assessment of the importance of vapor transport in the water balance of the waste rock dumps.

The material intercepted in the nine boreholes covers all types of waste rock (Aplite, unaltered (black) Andesite, propylitic Andesite, Tuff/Rhyolite; and hydrothermally altered mixed volcanics). It is evident from the preliminary data that the type of material and its location within the dump has a significant influence on the potential for ARD. Representative samples from each borehole and rock type have been selected for ABA testing and titration (see Work Plan for Geochemical Testing in section 4). A work plan for more detailed geochemical characterization (further static and kinetic testing) on a subset of these samples will be submitted after review of these initial results.

Water movement within the pile is of critical importance in determining the load of oxidation products that may be released into the environment. Most instrumented waste rock piles appear to be relatively "dry", i.e. showing (gravimetric) moisture contents typically less than 10% with no clear signs of a wetting front. No free water was observed during drilling or during subsequent monitoring of the standpipe piezometers slotted at the base of each pile. The data strongly suggest that water movement in the waste rock dumps is slow and occurs as unsaturated flow. The moisture movement within the waste rock piles will have to be monitored and modeled. Provisions are made in the five-year work scope to install soil suction/moisture sensors and measure net infiltration in the upper few meters of the waste rock material. Representative waste rock samples will be collected this fall (from trenches) and physically characterized (see Work Plan for Physical Testing in section 5). Monitoring of soil moisture fluxes are scheduled to begin in the spring/summer of 2000 using infiltration test plots. A work plan for the design, installation and monitoring of infiltration test plots will be provided after review of the results of the physical tests.

3 WORK PLAN FOR DUMP MONITORING

The following work plan outlines the scope of dump monitoring to be carried out at the nine instrumented boreholes. The scope of the monitoring program will be reviewed and likely reduced after one full year of monitoring (in September 2000).

3.1 Parameters

In the original work scope provisions were made for monitoring dump temperature, oxygen and carbon dioxide (in pore gas) at various depths of the nine boreholes (Molycorp, 1998). The in-situ dump temperatures are monitored using dedicated thermistors and the pore gas constituents (O_2 and CO_2) are monitored using a Nova 309BCWP portable gas analyzer (the analyzer is equipped with a small air pump, which delivers pore gas from the sampling port to surface). It is essential that all three parameters be measured during the same visit.

A review of the initial monitoring data has indicated that thermal convection is common in the dumps which may result in significant movement of water vapour in waste rock influencing the water balance of the dump (see section 2.4). In order to further assess this mechanism an attempt will be made to measure the relative humidity in the pore gas at the various boreholes. The pore gas will be pumped into an insulated chamber using an air sampling pump (e.g. HFS 513 or equivalent). The insulated chamber is a modified calibration chamber in which the probe of a portable thermo-hygrometer (e.g. Hanna Instruments 8564 or equivalent) is inserted. The probe measures the temperature and relative humidity in the air stream passing through the chamber. Pore gas will be pumped through the chamber until temperature and relative humidity readings have stabilized.

In order to quantify the effect of thermal convection on the water balance of the waste rock dumps (due to internal drying) the process of air flow has to be modeled. The air flow model is very much alike to a groundwater flow model (in fact both are based on Darcy's law) only that air flow is driven by gradients in air pressure (as opposed to hydraulic head) and the amount of air flow is governed by the air permeability (as opposed to hydraulic conductivity). We recommend measuring air (barometric) pressure at selected depths of the instrumented dumps using the access tubing for pore gas monitoring. A differential pressure transducer (full scale of about 150 mbar) should be used for this purpose which is attached to the end of the air tube at surface (providing a good seal). This transducer will read the differential air pressure between the sampling port and the ambient air pressure at surface. An additional pressure transducer (full scale readout of ~1000 mbar) will be required at surface to convert the readings to total air pressure. Both transducers should be hooked up to a data logger to allow automated monitoring of air pressure at the required frequency (say half hour intervals).

During each site visit the local weather conditions at each borehole should also be recorded including air temperature, relative humidity, precipitation and snow depth/water equivalent.

3.2 Routine Monitoring

The routine monitoring is designed to investigate the seasonal changes in dump temperatures and associated changes in pore gas composition. To this end, dump temperature and the pore gas constituents (O_2 and CO_2) will be measured monthly at all stations for the first year of installation.

Relative humidity measurements in pore gas will also be taken for one quarter, i.e. three rounds of monthly readings (provided the set-up for measuring relative humidity proves reliable). The humidity measurements should be taken immediately after the temperature and O_2/CO_2 readings, i.e. during the same site visit. The frequency of further monitoring of relative humidity in pore gas (beyond 3 months) will be determined after review of the results of this initial three-month period.

Air pressure readings (at least hourly) should be taken for an initial evaluation period of three months (provided the proposed set-up for measuring air pressure proves reliable). We recommend measuring air pressure at differing depths and locations (by moving the transducer to a different access tube every say 14 days) to obtain a feel for the variability within and between piles. The frequency of further monitoring of air pressure in pore gas (beyond 3 months) will be determined after review of the results of this initial three-month period.

3.3 Monitoring of "Extreme Events"

The effect of extreme weather conditions on dump temperatures and pore gas composition will be assessed by detailed monitoring. Detailed monitoring will take place during the following "extreme events":

- day with unusually low air temperature ("very cold day");
- day with unusually high air temperature ("very hot day");
- passage of a frontal system (with large changes in barometric pressure and air temperature).

During the "very hot" and "very cold" days, temperature and O_2/CO_2 readings will be taken once in all nine boreholes. During the passage of the frontal system, temperature and O_2/CO_2 readings will be taken every four hours in the three boreholes located in Sugar Shack South (WRD-3 to WRD-5) over a period of one day (6 rounds of readings per borehole in total).

If monitoring of a frontal system proves difficult this monitoring campaign can be replaced with monitoring the diurnal changes of dump temperature and O_2/CO_2 concentrations in pore gas during a very clear day (with associated diurnal variations in temperature).

Air pressure should also be recorded at selected locations during "extreme event" monitoring (an analysis of the routinely collected data (hourly readings) will likely suffice). An analysis of the air pressure changes within the dumps in response to barometric changes (e.g. passage of a frontal system) can be used to estimate the in-situ air permeability in a given region of the pile.

4 WORK PLAN FOR GEOCHEMICAL TESTING

4.1 Objectives

The geochemical testing program discussed here comprises static and kinetic testing of the Questa waste rock samples collected from the borehole drilling program (Task 1.5 of five-year program). The purpose of the geochemical testing program is to characterize the Questa waste rock with respect to its acid generation and acid consuming potential, metal leaching and mobility characteristics and likely water quality conditions in both the near and long term.

4.2 Previous Work

A preliminary characterization of the Questa waste rock material was done in 1995 and is summarized in the SRK Report entitled "Questa Molybdenum Mine: Geochemical Assessment". This earlier study was of limited scope with respect to geochemical characterization of the waste rock material. The geochemical assessment included Acid Base Accounting (ABA) testing, whole rock analyses (ICP) and shake flask leaching analyses on selected waste rock samples collected at surface. Table 2 summarizes the number of samples submitted for each test with respect to rock type.

Table 2. Summary of rock types tested in previous study (after SRK, 1995)

Rock Type	No. of Samples Collected	ABA Analyses	Whole Rock Analyses	Shake Flask Extraction Test
Hydrothermal Scar	9	2	4	7
Aplite/Granite	8	7	5	1
Black Andesite	10	7	2	3
Mixed Volcanics	21	15	8	15

This initial work indicated that "the black andesite and aplite/granite rock types had negligible to low potential to generate acid and limited potential for leaching sulfate and metals. The mixed volcanic rock type, which comprises the majority of the waste rock dumps, was determined to have a significant potential to generate acid and leach contaminants such as sulfate, copper, manganese and zinc (SRK, 1995)."

4.3 Scope of Work

The overall scope of work for the geochemical testing of the waste rock samples collected during the waste rock drilling program has been outlined in the five-year program (Molycorp, 1998). The sampling and geochemical testing was designed to augment the results from the preliminary geochemical testing (SRK, 1995).

The geochemical testing program has been subdivided into a static testing program (Task 1.5a) and kinetic testing program (Task 1.5b). The static testing will include the following tests:

- Whole rock (ICP) analysis
- ABA analyses
- Petrographic mineral analysis
- X-ray diffraction analyses
- Nevada meteoric water extraction tests
- Titration testing

The kinetic testing program proposed in the same document consisted of the following:

- Humidity cell tests (large cells with coarse waste)
- Petrographic and X-ray analyses of residues
- Oxygen consumption rate tests
- Column leach/buffering tests

A staged approach to the testing program is proposed here, whereby samples are first submitted for ABA and forward acid titration testing (Phase 1a). Once the results are reviewed, a subset of samples will be selected for the remaining tests of the static testing program, i.e. whole rock chemistry (ICP), leach extraction testing and mineralogical (petrography and XRD) analysis (Phase 1b). Similarly, once results of the Phase 1b testing are available, samples can be selected for the kinetic testing program (Phase 1c).

Confirmation from NMED with respect to the sample selection will be sought prior to each phase of testing. This work plan details the sample selection for the first set of testing in Phase 1a.

4.4 Phase 1a Testing

As described above, Phase 1a of the geochemical testing program will consist of Acid Base Accounting (ABA) and titration testing. ABA results will provide initial classification of samples as to their potential for acid generation or acid consumption. The forward titration procedure is used to determine, qualitatively, the acid neutralization capacity of the sample as well as the pH range, and therefore mineralogical component, that may provide effective buffering in the field. The test protocols were provided in the letter submission to the NMED dated June 17 1999 (Molycorp, 1999).

A total of 55 samples (including 4 duplicates) from these drill holes have been selected for Acid Base Accounting (ABA) analyses. 11 of these samples have also been selected for forward acid titration analyses. The samples selected for testing are indicated on the drill hole logs provided in Appendix A and are summarized in Table 3 below.

Table 3. Summary of samples selected for Phase 1a of the geochemical testing program[1].

Drill hole	No. of Samples	General Unit Description[1,2]
WRD-1	3	Predominantly aplite samples
	3	Predominantly "black" andesite
	1	Predominantly propylitically altered andesite
WRD-2	4	Predominantly hydrothermally altered mixed volcanics
WRD-3	1	Predominantly hydrothermally altered rhyolite
	3	Hydrothermally altered mixed volcanics (predominantly andesite)
	2	Unaltered (to slightly altered) andesite
WRD-4	2	Hydrothermally altered mixed volcanics
	2	Unaltered mixed volcanics
WRD-5	1	Predominantly rhyolite
	2	Hydrothermally altered mixed volcanics (predominantly andesite)
	1	Predominantly unaltered (to slightly altered) andesite (+/- rhyolite)
	2	Predominantly propylitically altered andesite
WRD-6	3	Hydrothermally altered mixed volcanics
	3	Rhyolite/Tuffs
	1	Unaltered mixed volcanics
WRD-7	2	Hydrothermally altered mixed volcanics (+/- aplite)
	2	Unaltered mixed volcanics (+/- aplite)
	2	Rhyolite
WRD-8	5	Tuff
WRD-9	2	Unaltered (to slightly altered) mixed volcanics (+/- andesite)
	3	Rhyolite/tuffs
	1	Hydrothermally altered mixed volcanics
SUBTOTAL	51	
DUPLICATES[3]	4	
TOTAL	55	

Notes:

[1] see text for details on geochemical units

[2] detailed field descriptions are provided on drill logs in Appendix A.

[3] QA/QC duplicates were chosen covering the 4 primary geochemical units and are indicated on the tables in Appendix A (i.e. one hydrothermally altered mixed volcanic, one aplite, one unaltered andesite and one tuff sample)

The waste rock samples have been categorized into 5 general 'geochemical units'. These are:

- Predominantly aplite samples;
- Predominantly unaltered volcanics (including 'black' andesite);
- Predominantly propylitically altered andesite;
- Predominantly hydrothermally altered mixed volcanics; and
- Rhyolites/tuffs.

The term "altered" used here for classification purposes refers to alteration occurring pre-mining (i.e. hydrothermal alteration of some type) and does not imply alteration due to weathering post deposition (such as sulfide oxidation). It is expected that these units may be reclassified (either combined or subdivided) based on the results of the geochemical testing program.

Samples were selected at various depths in each of the drill holes in order to obtain a representative range of waste material types from each bore hole (see Appendix A). An attempt has been made to select samples which are representative of the range of rock types, alteration (i.e. hydrothermal, propylitic etc.), degree of weathering, paste pH and paste conductivity values, as well as temperature, oxygen and carbon dioxide content characteristics.

Additional samples were selected in those locations where:

- an 'acid front' is suspected at a specific depth within a drill hole (e.g. WRD-5),
- significant depletion in oxygen and/or increase in carbon dioxide was observed (e.g. WRD-6),
- unexpected paste pH and/or paste conductivities were seen for a certain rock type (e.g. low paste pH and very high paste conductivity for aplite in WRD-2), and
- advection/convection is anticipated to be a large factor in air transport (e.g. WRD-2).

It should also be noted that an intentional sampling bias with respect to potentially acid generating material is inherent in the program, as the majority of drill holes were located in areas believed to be of a more potentially acid generating nature. These locations were specifically selected to investigate the processes controlling ARD production and evolution in the waste rock.

The proposed sample selection provided in this work plan is believed to reflect the range of material characteristics present in the Questa waste rock dumps. Approximately 6% of the samples selected are aplite samples, 25% are unaltered volcanics (including the 'black' andesite), 6% are propylitcally altered andesites, 33% are hydrothermally altered mixed volcanics and 30% are rhyolite/tuff samples. The latter 2 groups (or 63% of selected samples) are likely comprised of potentially acid generating material and the former 3 groups (or 37% of selected samples) are expected to fall in the 'uncertain' or 'non acid generating' categories.

Note that hydrothermal scar material will also be selected for ABA testing once the drilling in the scar areas is completed and the field logs and the results of the preliminary geochemical characterization (paste pH and paste conductivity) have been reviewed. Once completed, a list of proposed borehole samples for ABA testing will be submitted to the NMED.

A progress report will be submitted with the results of the Phase 1a testing, initial interpretation and graphical presentation of the data together with a proposed subset sample selection for subsequent testing.

4.5 Phase 1b Testing

Phase 1b will consist of a subset of samples for testing via whole rock chemistry (ICP), leach extraction testing and mineralogical (petrography and XRD) analyses. As with Phase 1a presented above, a progress report will be prepared upon completion of the testing which will include a suggested sample selection for Phase 1c (kinetic testing).

4.6 Phase 1c Testing

Kinetic tests are time-dependent and relatively costly (kinetic tests may run for as long as 9 months or possibly longer). Therefore it is suggested that all static testing (Phase 1a and 1b) will be completed before sample selection is finalized for kinetic testing to ensure that appropriate representative samples, with known static test characteristics, are selected for the latter testing. A progress report will be prepared and submitted following completion of the kinetic testing program.

5 WORK PLAN FOR PHYSICAL TESTING

5.1 Objectives

The physical testing program comprises geotechnical and geohydrological characterisation of the Questa waste rock material (Task 1.6 of five-year program). The purpose of this physical testing is as follows:

- to physically characterize and classify the waste rock;
- to determine engineering properties for stability analyses;
- to determine soil moisture and hydraulic conductivity characteristics required for the development of physical models for water balance and infiltration modeling; and
- to provide data for the assessment of the various waste rock types as potential cover material.

The results of this testing program will also be used in the design of the infiltration tests plots and subsequent infiltration modeling.

The field program (consisting of sample collection and field measurements) will be carried out in the fall of 1999 (pending approval by the NMED). This way, laboratory testing and subsequent design of infiltration test plots can be completed in the winter of 1999/2000 and installation of the test plots can begin in the spring of 2000.

5.2 Sampling

The sampling program is designed to obtain representative samples from the various waste rock types exposed at surface, i.e. aplite, black andesite, hydrothermally altered mixed volcanics (MV), and tuff/rhyolite. The following preliminary sampling locations have been selected:

- WRD-1 (aplite);
- WRD-3 (black andesite);
- WRD-4 (hydrothermally altered mixed volcanics);
- WRD-5 (hydrothermally altered mixed volcanics);
- WRD-6 (hydrothermally altered mixed volcanics); and
- WRD-8 (tuff)

These preliminary sampling locations have been selected based on the geochemical and physical description of the samples recovered from the various boreholes. The three sites selected in hydrothermally altered mixed volcanics (WRD-4, 5 and 6) differ with respect to compaction (loose material at angle-of-repose slope near WRD-4 versus compacted haul road at WRD-5) and slope orientation (slopes near WRD-6 and WRD-5/6 facing west and south, respectively.

Sampling will be done at a distance of at least 30m of the borehole in order to minimize the impact on the waste rock area being monitored. Alternative sampling locations may have to be selected in the field depending on the materials encountered at each site.

The sampling will be done under the supervision of a specialist geotechnical engineer and a hydrogeologist. Where feasible a trench will be dug to a depth of about 9-12 ft (3-4 m) using an excavator. The trench will be dug in layers of approximately 3 ft (1 m) thickness and the in-situ density of the waste rock material be determined, if feasible, at these 3ft intervals (using the "sand cone method", see section 5.3). Material from each 3ft interval will be placed in a separate pile, photographed and described with respect to chemical composition (lithology, paste pH, paste conductivity) and physical appearance (color, texture, visual estimate of grain size distribution). The side walls of the trenches will be examined and logged with respect to layering, grading, texture and presence of macropores. Two to three representative grab samples will be taken from each trench covering the range of grading/compaction observed in the trench (at a minimum one sample from the near-surface and one sample from depth).

At several sampling stations located mid-slope (e.g. WRD-4) a face will be dug into the slope (using a backhoe with extended arm) to expose the internal structure of the material (layering, grading etc.). The side walls will be photographed and logged with respect to layering, grading, texture and presence of macropores. At these locations, grab samples will be taken either by hand (if safe) or by using the backhoe.

Grab samples from the trenches and test pits will be collected in five 5-gal plastic buckets (i.e. a total sample size of about 250-300 lbs per sample). An additional 5-gal bucket will be filled with material passing the ¾ inch screen. All buckets will be labelled, sealed and weighted on-site. Three buckets of the bulk sample will be sent out immediately for initial geotechnical testing (grain size and moisture content). The remaining two buckets of the bulk sample and the pre-screened sample will be stored on site for potential future testing.

5.3 Field Measurements

The following field measurements will be taken during the field program in the fall of 1999:

- field reconnaissance;
- in-situ density measurements; and
- ponded infiltrometer tests.

The field program will begin with a site reconnaissance of the Questa waste rock dumps. The different waste rock dumps will be visited, sampling locations finalized and staked out. Selected waste rock faces (slopes) will be walked and the toes of the larger dumps visited to map and photograph the physical segregation along the rock slope.

In-situ density measurements will be taken at each sampling site using the "sand cone method". Depending on site conditions, additional readings will be taken with a nuclear densometer probe. This work will be performed by a local contractor with experience in such measurements. At a minimum, 2-3 sand cone measurements will be taken per trench at different depths (or 1-2 sand cone measurements per test pit in a slope). The densometer readings will be calibrated using these sand cone measurements. A minimum of 8-10 calibration points covering a range of conditions will be required.

Infiltrometer tests will be carried out to measure the in-situ (saturated) hydraulic conductivity using a ponded infiltrometer. A series of infiltrometer tests will be conducted covering a range of waste rock types and surface conditions (degree of weathering and compaction etc..).

5.4 Laboratory Testing

Table 4 lists the geotechnical and geohydrological laboratory tests to be performed on the various waste rock samples. The tests will be carried out in an accredited soil laboratory in accordance with standard procedures (see Table 4).

Table 4. Summary of Laboratory Tests of Physical Testing Program.

Test	Protocol	Material Type			
		Aplite/ Granite	Black Andesite	Hydrothermally Altered Mixed Volcanics	Tuff
Standard Sieve (Wet)/Hydrometer	ASTM D 422-63(90)	2	2	7	1
Moisture Content (Bulk and Splits)	ASTM D 2216	2	2	7	1
Compaction (Proctor) Test	ASTM D 698-91	1	1	2	1
Shear Strength	ASTM D 3080	1	1	2	1
Saturated Hydraulic Conductivity*	MOSA[1] CHP.28 or ASTM D 2434-68	1	1	3	1
Moisture Retention Characteristics* (SWCC)	MOSA CHP. 26; ASTM D 2325-68(94) and MOSA CHP. 24	1	1	3	1
Freeze-Thaw (Rock Specimen)	ASTM D 5312	1	1	1	1
Wet/Dry (Rock Specimen)	ASTM D 5313	1	1	1	1

* Specific protocols used depend on material properties.

[1] Methods of Soil Analysis, Part 1, 1986. A. Klute, ed. American Society of Agronomy, Madison, WI.

The geotechnical testing will include gradation, compaction (Proctor) testing and shear strength testing. The durability of the waste rock will be evaluated by exposing fist-sized rock specimen to 35 freeze-thaw cycles and 80 wet-dry cycles and recording the loss of intact rock mass (ASTM D 5312 and D5313, respectively).

The geohydrological testing of the waste rock samples will include saturated hydraulic conductivity testing and measurement of the soil moisture retention characteristics (also referred to as soil water characteristic curve, SWCC). Table 4 lists the proposed testing procedures. The selection as to which test protocol to use will depend on the material properties of the waste rock sample. The unsaturated hydraulic conductivity as a function of suction (Hydraulic Conductivity Function) for a given sample will be calculated from the moisture retention data, grain size curve and saturated hydraulic conductivity.

Initially, grain size analyses will be performed on all grab samples from the trenches and smaller test pits. Based on a review of the grading curves specific samples will be selected for further testing. Table 1 lists the proposed number of samples grouped by rock type for each test. A higher proportion of the finer-grained waste rock samples (hydrothermally altered mixed volcanics and tuff) will be tested compared to the durable aplite/granite and "black" andesite samples. This bias reflects the higher proportion of these rock types at the surface of the instrumented waste rock dumps. The physical characteristics of the waste rock material at or near the surface are considered more critical for understanding the net infiltration of precipitation into the dumps. The results of the geotechnical and physical testing program will be summarized in a progress report to be submitted to the NMED.

6 REFERENCES

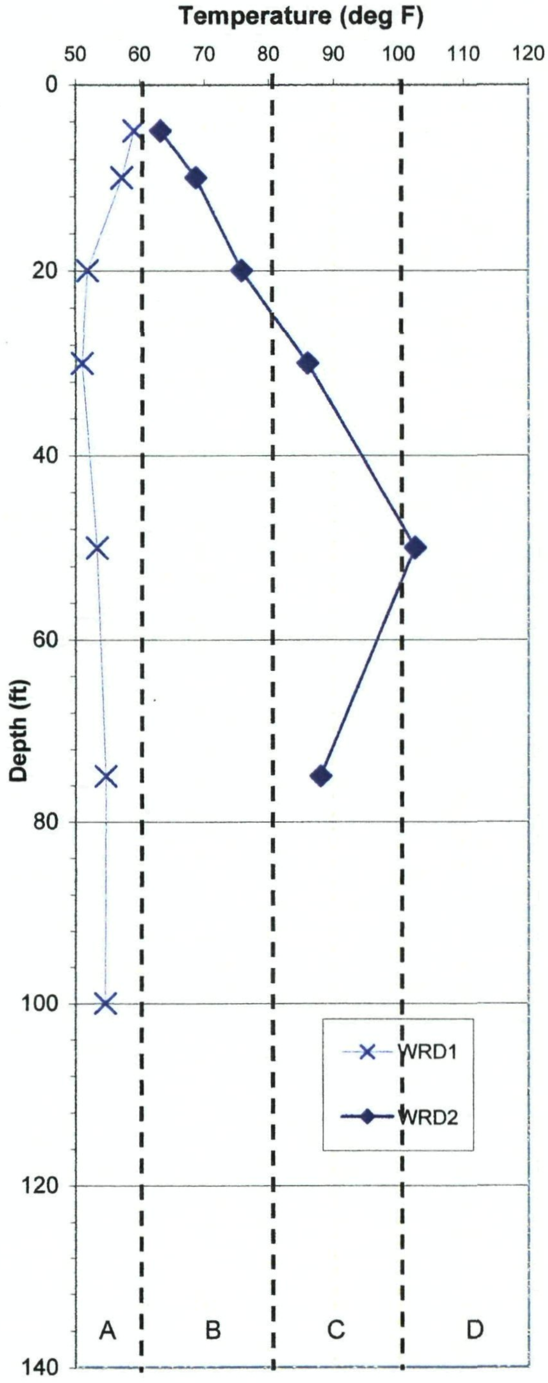
Molycorp, 1998. "Questa Mine Waste Rock Discharge Plan – Molycorp's Response to Comments by NMED on Discharge Plan Application for Waste Rock, DP-1055". Letter report submitted to NMED, July 31, 1998.

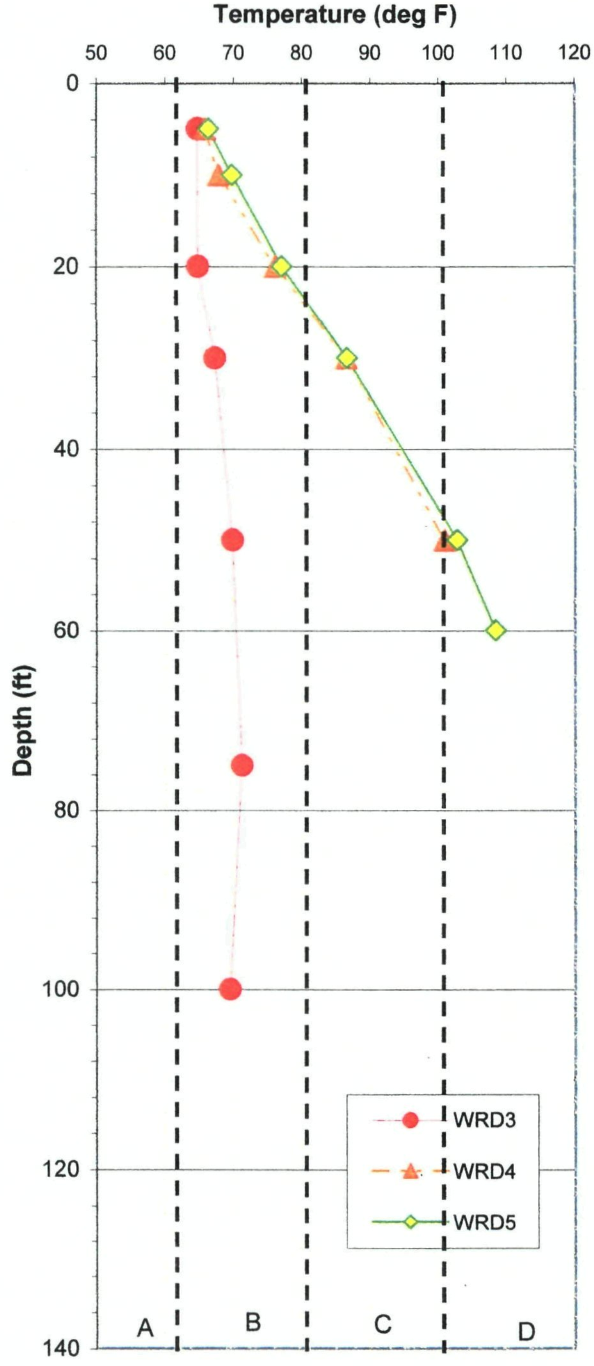
Molycorp, 1999. "Questa Mine Waste Rock Discharge Plan – Response to Comments and Requests by the Groundwater Water Quality Bureau in Letter dated April 29, 1999". Letter report submitted to NMED, June 17, 1999.

Robertson GeoConsultants Inc., 1999. "Interim Report: Questa Waste Rock Pile Drilling,Instrumentation and Characterization Study". RGC Report 052007/1 prepared for Molycorp, September 6, 1999.

SRK, 1999. "Questa Waste Rock Investigation: Waste Pile Instrumentation As-Built Report. SRK Report 09215 prepared for Molycorp, September 1999.

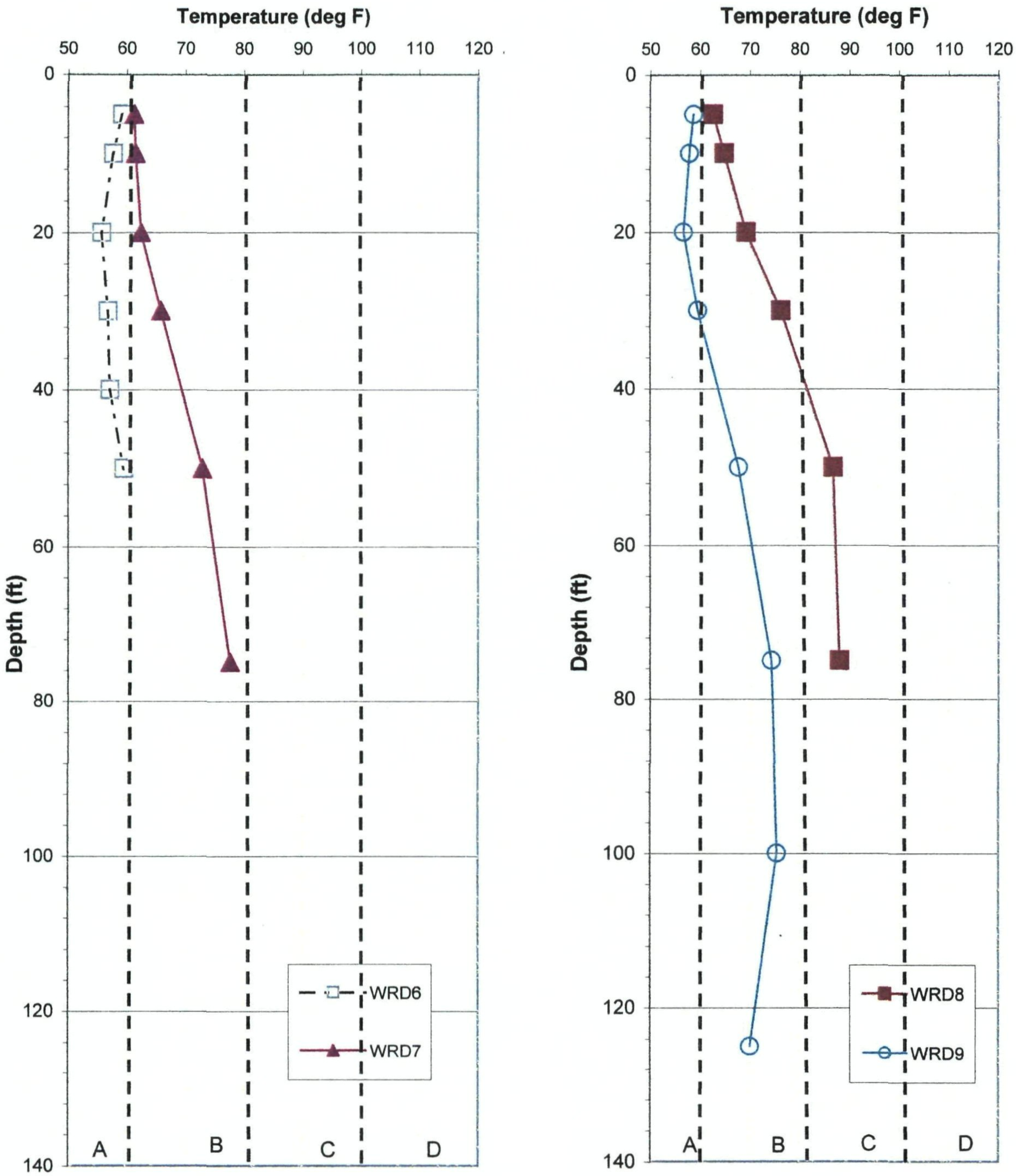
Figures





ZONE A = T < 60F (very little or no potential for advective air flow)
ZONE B = T between 60F and 80F (moderate potential for advective air flow)
ZONE C = T between 80F and 100F (high potential for advective air flow)
ZONE D = T > 100 F(very strong potential for advective air flow)

Figure 1a. Temperature versus Depth - Sep 16/17 1999



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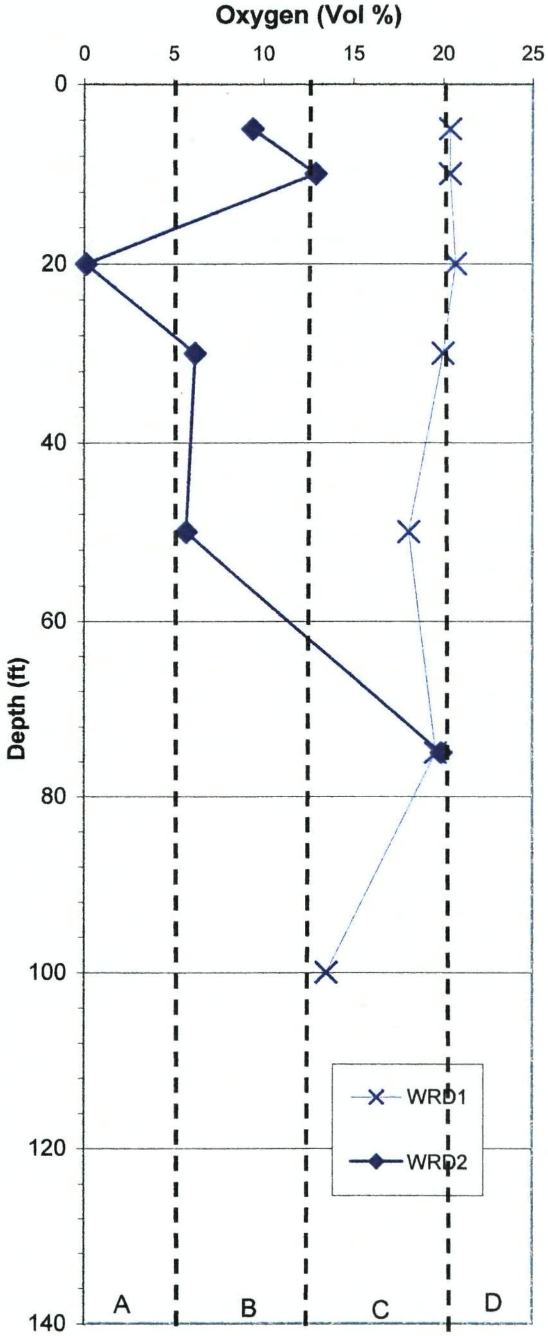
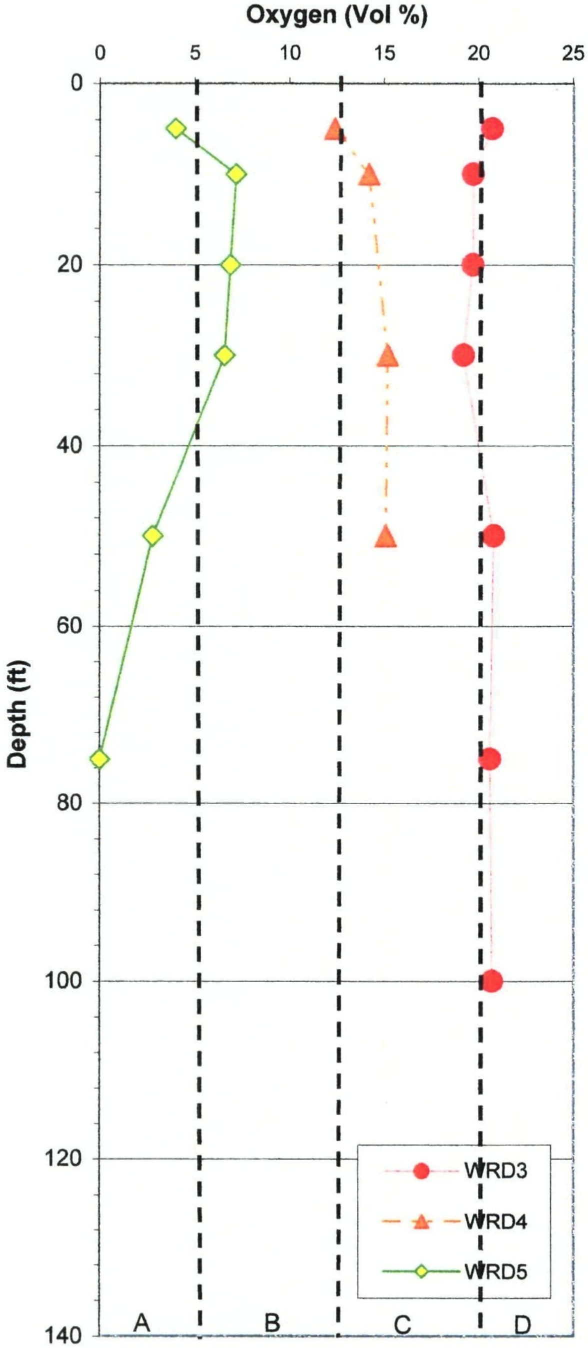
ZONE B = T between 60F and 80F (moderate potential for advective air flow)
ZONE C = T between 80F and 100F (high potential for advective air flow)
ZONE D = T > 100 F(very strong potential for advective air flow)

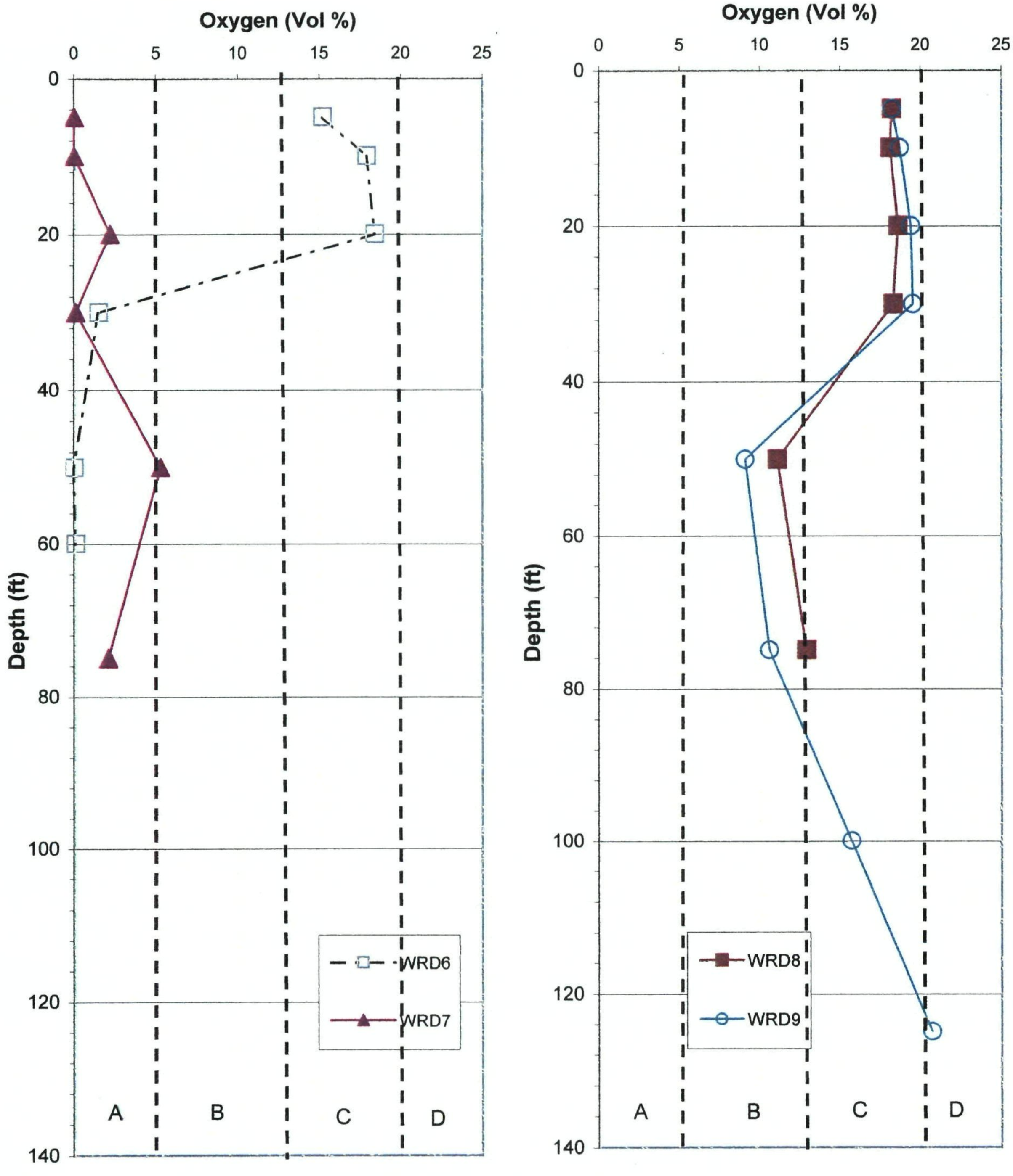
Figure 1b. Temperature versus Depth - Sep 16/17 1999





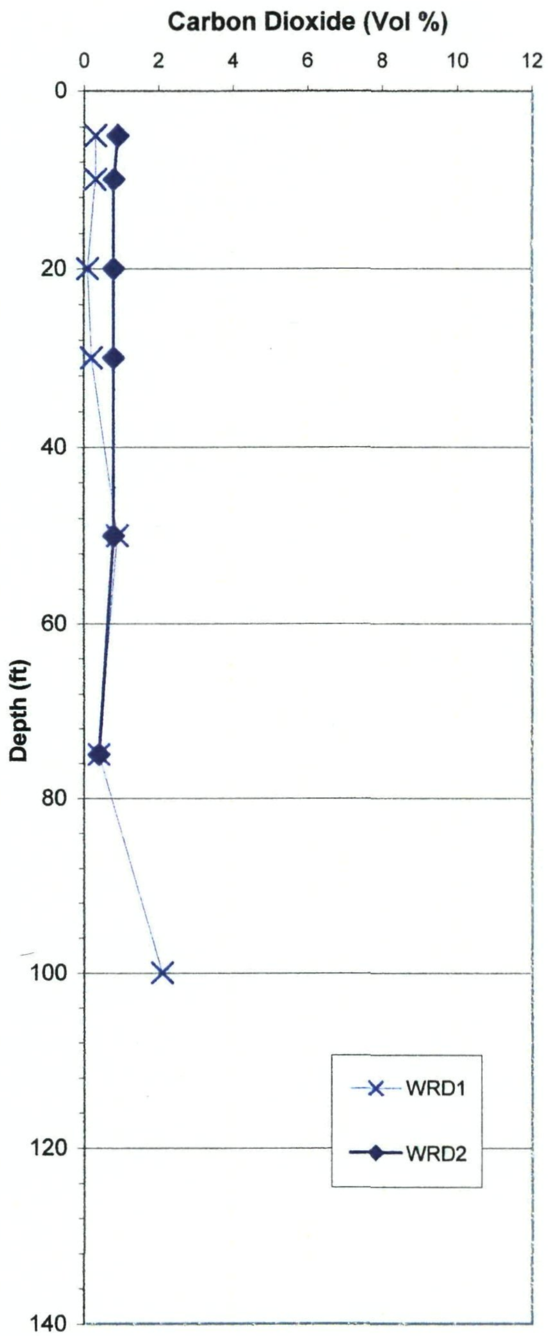
ZONE A = O2 < 5% (very strong depletion of oxygen)
ZONE B = O2 between 5% and 12.5% (strong oxygen depletion)
ZONE C = O2 between 12.5% and 20% (moderate oxygen depletion)
ZONE D = O2 > 20% (no oxygen depletion - background)

Figure 2a. Oxygen versus Depth - Sep 16/17 1999



ZONE A = O2 < 5% (very strong depletion of oxygen)
ZONE B = O2 between 5% and 12.5% (strong oxygen depletion)
ZONE C = O2 between 12.5% and 20% (moderate oxygen depletion)
ZONE D = O2 > 20% (no oxygen depletion - background)

Figure 2b. Oxygen versus Depth - Sep 16/17 1999



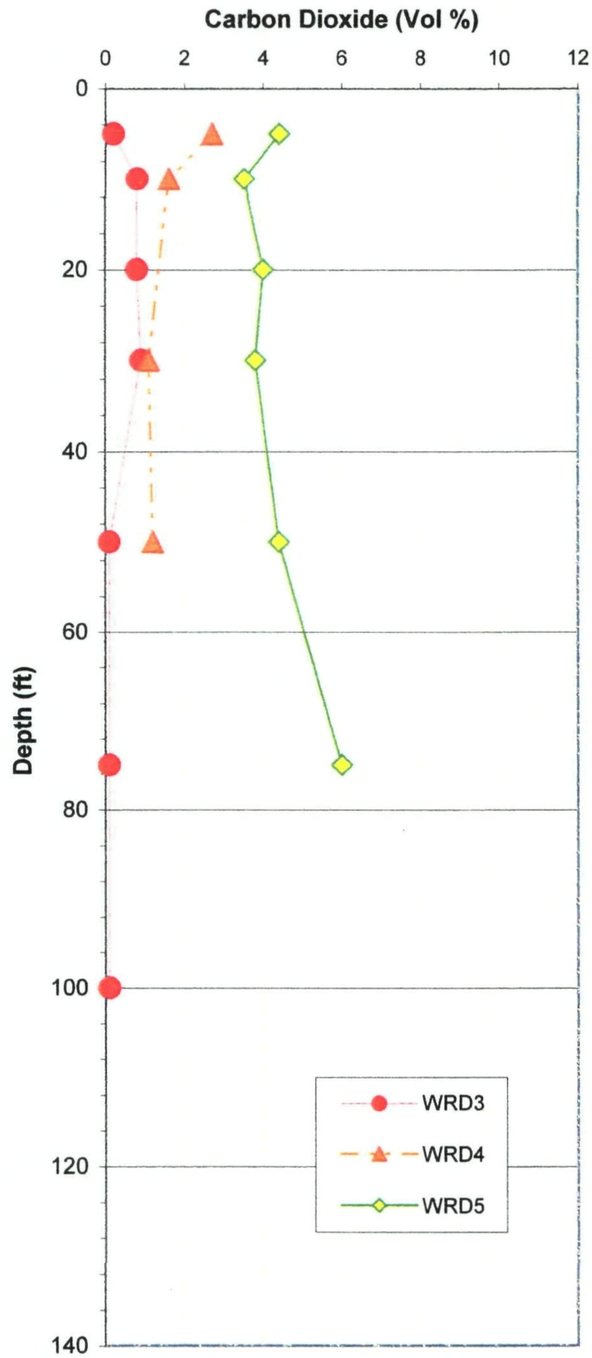
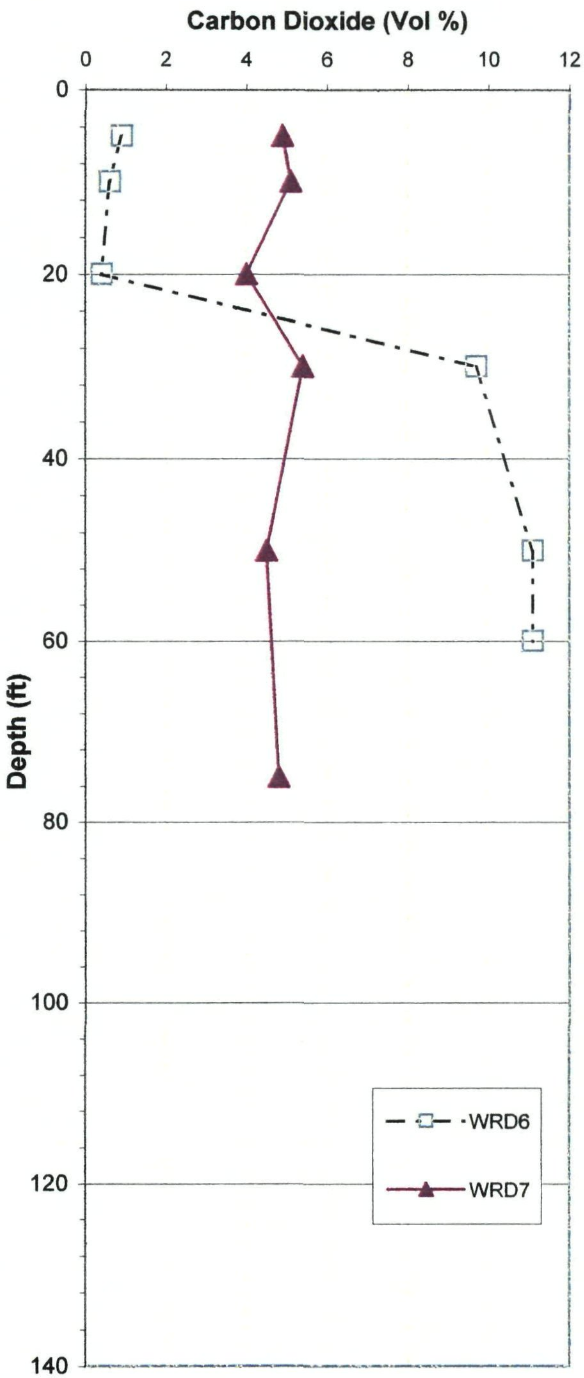


Figure 3a. Carbon Dioxide versus Depth - Sep 16/17 1999



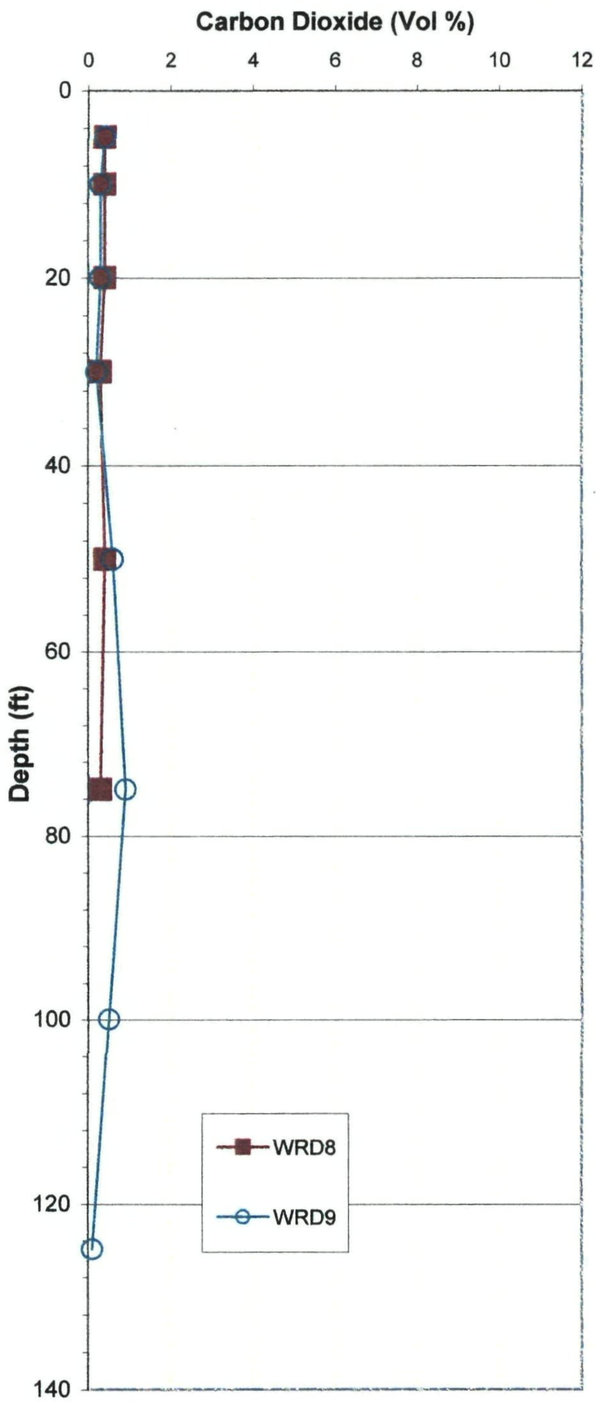


Figure 3b. Carbon Dioxide versus Depth - Sep 16/17 1999

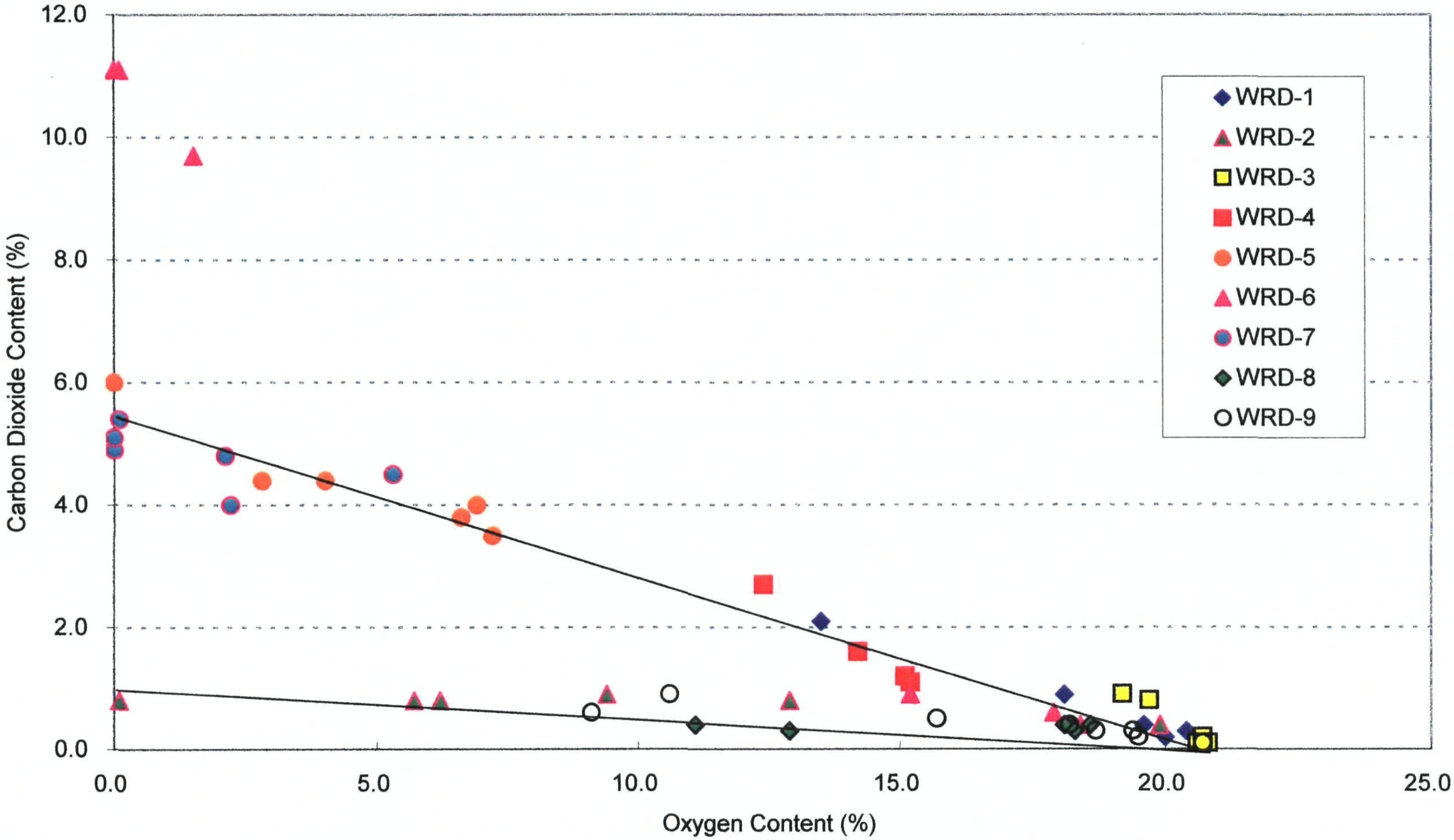


Figure 4. Carbon-dioxide Content vs Oxygen Content in Waste Rock Pore Gas - Sep 16/17 1999.

Appendix A

Drill Hole Logs for Phase 1a Geochemical

Characterization Program

Table A1. Drill Hole Log for WRD 1 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 1
Driller: Layne Western Drilling
Equipment: *AP-1000 Hammer Drill*

Start Date 7/31/99
End Date 7/31/99

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (μS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing
0	5	Aplite, light grey, minor Pyrite, tan matrix	dry	8.37	634	5.1				
5	10	Aplite, minor Pyrite, w/ Andesite, tan matrix	dry	7.98	1,040	1.6		X		X
10	15	Aplite, trace Pyrite, tan matrix	dry, poor recovery	7.93	1,380	4.0				
15	20	Aplite, minor Andesite, light grey, tan matrix	dry	7.67	1,850	4.8		X		
20	25	Aplite, light grey, tan matrix	dry	7.93	1,730	4.4		X	X	X
25	30	Andesite, >1% Pyrite, trace Molydenum, mineralized, brown matrix	dry ,color change to brown at ~27'	7.29	2,400	4.9				
30	35	Andesite, >1% Pyrite, Aplite, minor Rhyolite, Fluorite, Calcite, Trace Molydenum	dry	7.66	2,040	4.1		X		
35	40	Andesite, trace Pyrite, minor Aplite, Calcite, dark brown matrix	dry	7.73	2,200	6.2				
40	45	fresh Andesite, Calcite, dark grey to black, dark brown matrix	dry	7.68	1,750	5.0	C1A			
45	50	Andesite, trace Chalcopyrite, abundant Calcite, dark grey, dark brown matrix	dry	7.84	2,340	6.2				
50	55	Andesite, trace Pyrite, Calcite, dark brown matrix	dry	7.76	2,250	4.3		X		X
55	60	Andesite, porphyry, 1% Pyrite, minor calcite, dark brown matrix	dry	7.88	1,800	4.3				
60	65	Andesite, abundant Calcite, dark green-grey, propylitically altered, dark brown matrix	dry	8.11	2,070	4.7				
65	70	Andesite, trace Pyrite, abundant calcite, dark grey, dark brown-grey matrix		7.89	1,630	4.0				
70	75	Andesite, fresh trace Pyrite, dark grey, dark grey-brown matrix	dry	7.98	1,852	3.5		X		
75	80	Andesite, trace Pyrite, minor Calcite, dark grey-green, dark grey matrix	dry	7.46	1,650	2.5	C1B			
80	85	Andesite, minor Calcite, black, minor propylitic alteration, grey matrix	dry	8.16	1,065	2.4				
85	90	Andesite, trace Calcite, black, minor propylitic alteration, grey matrix	dry	8.16	1,296	1.6		X		
90	95	Andesite, black, fresh, grey matrix	dry	8.41	836	1.3	C1B			
95	100	Andesite, black, large blocks, fresh	dry	7.89	2,290	3.5				

Code:
- C1A — Composite sample for grain size analysis
- (light shading) — Sample for geochemical testing
- (dark shading) — Bedrock as inferred from drill action and borehole samples

Table A2. Drill Hole Log for WRD 2 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 2

Start Date 7/31/99
End Date 7/31/99

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing
0	5	mixed volcanics, mostly oxidized, yellow-brown clay rich matrix	dry	4.99	1,410	5.7	C2A			
5	10	mixed volcanics, trace Pyrite, oxidized, yellow-brown clay rich matrix	dry	4.02	2,670	5.6		X		
10	15	mixed volcanics, oxidized, yellow-brown clay rich matrix	dry	3.53	2,780	8.8	C2A			
15	20	mixed volcanics, trace Pyrite, oxidized, yellow-brown clay rich matrix	dry	3.17	3,820	6.9				
20	25	mixed volcanics, yellow-brown clay rich matrix	dry	3.68	4,110	8.3		X		
25	30	mixed volcanics, yellow-brown clay rich matrix	dry	3.38	3,140	10.7	C2B			
30	35	mixed volcanics, oxidized, yellow-brown clay rich matrix	dry	3.21	3,190	10.2				
35	40	mixed volcanics, trace Pyrite, oxidized, yellow-brown matrix	moist	3.34	2,840	9.3	C2C			
40	45	mixed volcanics, trace Pyrite, oxidized, yellow-brown clay rich matrix	moist	3.22	3,730	9.6		X		
45	50	mixed volcanics, trace Pyrite, oxidized, yellow-brown clay rich matrix	moist	3.14	5,240	5.7	C2C			
50	55	mixed volcanics trace Pyrite, yellow-brown clay rich matrix	moist	3.17	6,440	6.3				
55	60	mixed volcanics, yellow-brown clay rich matrix	moist	3.28	6,370	5.8		X		X
60	65	Aplite, trace Pyrite, fresh blocks	dry	3.82	5,630	2.3				
65	70	Aplite, trace Pyrite, fresh blocks	dry, poor recovery	3.66	5,390	3.5				
70	75	Aplite, >1% Pyrite, fresh blocks	dry	4.15	4,220	2.0				

Code:
- C2A — Composite sample for grain size analysis
- (light shading) — Sample for geochemical testing
- (dark shading) — Bedrock as inferred from drill action and borehole samples

Table A3. Drill Hole Log for WRD 3 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 3

Start Date 7/30/99

End Date

Driller: Layne Western Drilling

Equipment: AP-1000 Hammer Drill

Logged By: A. Eschenbacher, SMA

G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing
0	5	Andesite, minor Aplite, trace Pyrite, gravel in tan sand, silt size matrix	dry, split sample	6.07	2,430	2.6		X		
5	10	Aplite, minor Andesite, fresh blocks	dry, split sample	8.02	948	0.4				
10	15	Andesite, minor Aplite, trace Pyrite, large fragments	dry, split sample, poor recovery	8.16	2,280	1.3	C3A			
15	20	Andesite, trace Pyrite, fresh blocks	dry, split sample, poor recovery	8.25	2,190	0.8				
20	25	Andesite, trace Pyrite, fresh blocks	dry, split sample	8.12	2,370	3.5		X		
25	30	Andesite, trace Pyrite, blocks, brown matrix	dry, split sample	7.94	2,290	4.8				
30	35	Andesite, blocks	dry, split sample	7.84	2,420	4.1				
35	40	Andesite, Aplite, blocks	dry, split sample	7.96	2,480	5.9				
40	45	Andesite, Aplite, Rhyolite fragments, trace to minor Pyrite,	dry, split sample	7.97	2,730	4.0	C3B			
45	50	Andesite, Rhyolite fragments, trace Pyrite	dry, split sample	8.27	2,150	2.3				
50	55	Rhyolite, minor Pyrite, fresh hydrothermally altered volcanics	dry, split sample	7.58	2,610	2.8		X	X	X
55	60	Andesite, trace pyrite, minor hydrothermally altered volcanic Pyrite	dry, split sample	6.35	2,450	2.4				
60	65	Andesite, minor Pyrite, hydrothermical alteration	dry, split sample	6.01	2,560	4.2				
65	70	few Andesite, fragments, yellow-brown matrix	dry, split sample	4.10	3,510	5.4	C3C			
70	75	Andesite, minor Pyrite, moderately hydrothermally altered, yellow-brown matrix	dry, split sample	3.90	3,630	5.1		X		
75	80	Andesite, minor Pyrite, minor Aplite, hydrothermally altered, yellow-brown matrix	dry, split sample	3.93	3,760	4.6	C3C			
80	85	Andesite, trace Pyrite, hydrothermally altered, yellow-brown matrix	dry, split sample	4.41	4,150	4.1				
85	90	Andesite, minor Pyrite, minor felsic volcanic Chalcopyrite, Rhyolite, hydrothermally altered, yellow-brown matrix	dry, split sample	6.59	3,740	3.3		X		
90	95	Andesite, trace Pyrite, minor Rhyolite, yellow-brown matrix	dry, large fragments	6.35	3,930	4.0				
95	100	Andesite, Rhyolite, mixed volcanics, fresh and hydrothermally altered, yellow-brown matrix	dry, split sample	4.64	3,270	3.8				
100	105	Andesite, Rhyolite mixed volcanics, yellow-brown matrix	dry, split sample	3.99	3,760	4.5		X		
105	110	Andesite, minor Rhyolite, mixed volcanics, fresh and hydrothermally altered, yellow-brown matrix	dry, split sample	4.61	3,560	3.6				
110	115	Andesite, minor Pyrite, slightly altered	dry, split sample	6.73	3,270	2.7				
115	120	Andesite, minor Pyrite, slightly altered	dry, split sample	5.68	4,090	2.0				

Code:

- C3A Composite sample for grain size analysis
- Sample for geochemical testing
- Bedrock as inferred from drill action and borehole samples

Table A4. Drill Hole Log for WRD 4 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 4

Start Date 7/29/99
End Date

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing
0	5	mixed volcanics, hydrothermally altered, coarse gravel, tan fines	dry, whole bucket sample	4.17	1,880	5.4				
5	10	volcanics, dark brown, hydrothermally altered, mostly clay-sand sized	dry, split sample	5.11	2,930	6.3		X		X
10	15	Andesite, Granite, angular gravel, light brown silt-clay matrix,	dry, split sample	7.40	2,400	5.5	C4A			
15	20	mixed volcanics, hydrothermally altered, dark brown fines	dry, split sample	7.19	2,720	6.7	C4A			
20	25	Aplite, Granite, Andesite, gravel	dry, split sample	7.87	2,810	4.2				
25	30	mixed volcanics, hydrothermally altered, drak brown matrix	dry, split sample	7.84	2,660	6.4		X		
30	35	volcanic, light grey, gravel, hydrothermally altered, tan matrix	dry, split sample	6.74	2,790	5.6	C4B			
35	40	volcanics, light grey, hydrothermally altered	dry, split sample	7.51	2,870	3.9	C4B			
40	45	mixed volcanics, grey, coarse blocks,tan matrix	dry, split sample	4.88	3,400	4.9		X		
45	50	volcanics, grey, coarse blocks,tan matrix	dry, split sample	4.68	3,100	4.5	C4C			
50	55	volcanics, grey, gravel <1" dia., tan matrix	slightly moist, split sample	4.85	4,160	6.6		X		
55	60	volcanics, grey, coarse gravel, tan matrix	slightly moist, split sample	7.78	4,170	4.9	C4C			
60	65	Andesite, dark grey, volcanic, angular, one lithology	moist, split sample	6.96	3,130	5.4				
65	70	Andesite, dark grey, volcanic,minor brown matrix, one lithology	moist, split sample	7.18	2,810	4.8				
70	75	Andesite, dark grey, volcanic, angular large fragments, slightly brown matrix	moist, more red hue than others	7.95	1,040	3.8				

Code:
- C4A — Composite sample for grain size analysis
- (light shading) — Sample for geochemical testing
- (dark shading) — Bedrock as inferred from drill action and borehole samples

Table A5. Drill Hole Log for WRD 5 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 5

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Start Date 8/1/99
End Date 8/1/99

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing
0	5	Andesite, Rhyolite, mixed vocanics, yellow-brown matrix	moist	6.18	2,590	6.8				
5	10	Rhyolite, minor Andesite, brown matrix	moist	7.84	1,880	4.7		X		
10	15	minor Aplite, mixed volcanics, yellow-brown clay rich matrix	moist	4.40	1,650	9.4	C5A			
15	20	Andesite, trace Pyrite, highly altered Rhyolite, black, mixed volcanics, yellow-brown (clay-rich) matrix	moist	3.66	3,000	11.6	C5A			
20	25	Andesite, minor Pyrite, highly altered Rhyolite, easily crumbled, yellow-brown clay rich matrix	moist	3.80	3,190	6.9		X		
25	30	Andesite, trace Pyrite, minor Rhyolite, dark grey, slightly oxidized, brown matrix	dry	5.11	3,750	6.4		X		
30	35	Andesite, Rhyolite, trace Pyrite, dark grey-brown matrix	dry	7.60	3,770	5.8	sample missing			
35	40	Andesite, dark grey-green, large blocks, propylitic alteration, grey matrix	dry	8.02	2,530	4.9		X		
40	45	Andesite, trace Pyrite, Calcite, dark grey-green, propylitic alteration, grey matrix	dry	8.03	3,280	4.2		X	X	X
45	50	Andesite, minor Pyrite, dark green-grey, grey matrix	dry	8.34	3,430	4.3	C5B			
50	55	Andesite, trace Pyrite, Calcite, dark grey-green, grey matrix	dry	7.89	3,640	4.5	C5B			
55	60	Andesite, drak grey, brown matrix	dry	7.67	2,530	4.6	C5B			
60	65	Andesite, Rhyolite, mixed volcanics, fresh and altered, dark brown matrix	dry	6.52	2,510	6.4		X		
65	70	trace Pyrite, mixed volcanics, large blocks oxidized, brown matrix	dry	7.73	1,510	7.4				
70	75	Andesite, trace Pyrite, Epidote, minor Rhyolite,dark grey-green, grey matrix	dry	8.11	1,050	4.9				
75	80	Andesite, minor Pyrite, dark grey, large blocks, uniform, grey matrix	dry							

Code:
- C5A — Composite sample for grain size analysis
- (light shading) — Sample for geochemical testing
- (dark shading) — Bedrock as inferred from drill action and borehole samples

Table A6. Drill Hole Log for WRD 6 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: *WRD 6*
Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Start Date 8/4/99
End Date 8/4/99

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing
0	5	mixed volcanics, yellow-brown clay rich matrix	moist	3.17	3,130	7.49		X		
5	10	mixed volcanics,dominant Tuff, trace Pyrite, grey, light brown clay rich matrix	moist	3.29	3,350	7.02	C6A			
10	15	mixed volcanics, fresh, highly altered varients (bleached, oxidized), light brown clay rich matrix	moist	3.53	3,200	10.45		X		
15	20	black Andesite,light grey Rhyolite/Tuff, mixed volcanics, light brown clay rich matrix	moist	3.62	2,960	11.25	C6A			
20	25	grey Rhyolite, minor highly altered volcanics (Rhyolite, trace Pyrite) light brown clay rich matrix	moist	3.94	2,970	8.84		X		
25	30	grey Rhyolite, trace Pyrite, (Tuff?), grey-brown matrix	moist, drier than above	4.48	2,830	6.20		X		
30	35	Tuff, trace Pyrite, grey, crystal, grey matrix	moist	7.37	2,860	5.66		X		X
35	40	Tuff, massive Pyrite, dark grey, very little banding, grey matrix	moist	7.50	2,430	6.24	C6B			
40	45	Tuff, >1% Pyrite, Epidote, dark grey, crystal, grey matrix	slightly moist	7.71	2,850	6.16				
45	50	mixed volcanics, grey Tuff, trace Pyrite, light grey Rhyolite, oxidized Rhyolite (?), grey-brown matrix	dry	7.64	3,090	4.66		X		
50	55	mixed volcanics, dominate Tuff, >1% Pyrite, dark grey, crystal, grey-brown matrix	dry	7.50	3,410	5.52		X		
55	60	Tuff, minor Pyrite, light grey, crystal, grey rock powder matrix	dry, competent rock-bedrock	7.81	2,950	3.98				

Code:
C6A Composite sample for grain size analysis
Sample for geochemical testing
Bedrock as inferred from drill action and borehole samples

Table A7. Drill Hole Log for WRD 7 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 7

Start Date 8/1/99
End Date 8/2/99

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing
0	5	Andesite, trace Pyrite, Aplite, yellow-brown matrix	dry	5.68	2,450	5.4				
5	10	mixed volcanics, Aplite, yellow-brown matrix	dry	3.84	2,570	5.7		X		X
10	15	Aplite, mixed volcanics, yellow-brown clayey matrix	moist (raining)	3.63	2,850	7.4	C7A			
15	20	mixed volcanics, Aplite, yellow-brown matrix	moist (raining)	3.09	3,140	10.4				
20	25	mixed volcanics, Aplite, yellow-brown matrix	dry	3.46	3,000	7.2		X		
25	30	mixed volcanics, dominate Andesite, brown matrix	dry	4.52	3,140	4.9				
30	35	mixed volcanics, brown matrix	dry	7.18	3,100	5.2		X		
35	40	mixed volcanics, dominant Rhyolite, rh prophyry, grey-brown matrix	dry	7.57	3,110	6.6	C7B			
40	45	mixed volcanics, Aplite, grey-brown matrix	moist (lightly raining)	7.57	2,600	6.6				
45	50	mixed volcanics, Aplite, brown matrix	dry	7.30	2,200	7.2		X		X
50	55	mixed volcanics, dominant grey Rhyolite, grey-brown matrix	dry	7.71	2,250	5.5				
55	60	mixed volcanics, dominate Rhyolite, grey matrix	moist	7.43	2,130	7.1		X		
60	65	grey Rhyolite, minor Andesite, grey matrix	moist	7.91	1,410	6.4	C7C			
65	70	mixed volcanics, dominate Rhyolite, grey-brown matrix	moist (lightly raining)	7.63	2,400	5.6				
70	75	light grey Rhyolite (partialy oxidized), minor Pyrite, minor black Andesite, trace Pyrite, yellow-brown matrix	dry	4.28	2,560	4.6		X		
75	80	Andesite, dark grey, fresh, prophyry, large blocks	dry bedrock	5.92	2,410	2.9				

Code:
- C7A — Composite sample for grain size analysis
- (light shading) — Sample for geochemical testing
- (dark shading) — Bedrock as inferred from drill action and borehole samples

Table A8. Drill Hole Log for WRD 8 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 8

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Start Date 8/3/99
End Date 8/3/99

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing
0	5	Grey welded tuff, volcanic brecia, dark brown matrix	moist	3.25	2,440	4.7				
5	10	Grey tuff, dark brown matrix	moist	3.47	2,480	6.2				
10	15	Grey tuff, crystal rich and crystal poor varieties, dark brown clay rich matrix	moist	3.16	2,740	6.4		X		
15	20	*Dark grey tuff, trace pyrite, dark brown clay rich matrix*	*moist*	3.23	2,730	6.5	C8A			
20	25	Dark grey tuff, minor pyrite, silicified, dark grey-brown matrix	moist	6.17	2,500	5.6				
25	30	Grey tuff, minor pyrite, silicified, dark grey-brown clay rich matrix	moist	3.89	2,950	6.7		X		
30	35	Grey tuff, trace pyrite, silicified, dark brown-orange clay rich matrix	moist	3.35	2,620	7.9				
35	40	Grey tuff, trace pyrite, crystal rich, brown-orange clay rich matrix	moist	3.07	2,910	8.0				
40	45	Grey tuff, trace pyrite, crystal rich, brown-orange clay rich matrix	moist	3.63	2,790	8.5		X		
45	50	Grey tuff, minor pyrite, crystal rich, grey-brown matrix	moist	3.98	2,680	8.5	C8B			
50	55	Grey tuff, minor Pyrite, grey-tan clay rich matrix	moist	3.91	2,570	9.3				
55	60	dark grey Tuff, trace Pyrite, crystal rich and crystal poor varieties, grey matrix	moist	4.11	2,870	7.3		X		X
60	65	dark grey Tuff, trace Pyrite, brown clay rich matrix	moist	4.02	2,760	7.8	C8C			
65	70	dark grey Tuff, crystal poor, light brown clay rich matrix	moist	3.79	3,050	8.7				
70	75	dark grey Tuff, trace Pyrite, light brown matrix	moist	3.95	3,100	8.7		X		
75	80	dark grey Tuff, trace Pyrite, light brown clay rich matrix	moist, drier than above	3.93	3,380	9.4				
80	85	Tuff, light grey, fresh, light brown matrix	dry	3.86	3,150	7.4				

Code:
- C8A — Composite sample for grain size analysis
- (light shading) — Sample for geochemical testing
- (dark shading) — Bedrock as inferred from drill action and borehole samples

Table A9. Drill Hole Log for WRD 9 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 9
Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill
Start Date 8/2/99
End Date 8/3/99
Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing
0	5	Mixed volcanics, trace pyrite, oxidized clasts, light brown matrix	dry	3.10	2,780	7.3	C9A			
5	10	Mixed volcanics, brown clay rich matrix	moist	3.79	1,660	9.6				
10	15	Mixed volcanics, dominate andesite, black, brown clay-rich matrix	moist	3.21	3,480	7.9		X		
15	20	black Andesite, trace Pyrite, brown clay rich matrix	moist	3.05	2,910	6.6	C9A			
20	25	Black andesite, trace pyrite, minor grey rhyolite, brown matrix	moist	3.26	2,250	6.5		X		
25	30	Tuff, dark grey, welded, brown matrix	dry, poor recovery	4.01	2,550	5.6				
30	35	Mixed volcanics, andesite, trace pyrite, rhyolite, tuff, brown matrix	dry, poor recovery	3.23	2,840	5.6				
35	40	Grey rhyolite, dark grey tuff, welded, light brown matrix	dry, poor recovery	3.41	2,630	6.5				
40	45	Rhyolite, light grey, fresh, large blocks, light brown-grey matrix	dry	3.24	1,290	6.1				
45	50	Rhyolite, light grey, fresh, large blocks, light brown-grey clay rich matrix	dry	2.89	1,720	6.9		X		
50	55	Grey rhyolite,tuff, welded, light brown clay rich matrix	moist	3.01	3,110	8.7				
55	60	Tuff, grey, welded, light brown clay rich matrix	moist	3.56	4,280	9.8	C9B			
60	65	grey welded Tuff, minor oxidized Tuff with trace Pyrite, light brown clay rich	dry	3.67	3,980	6.9				
65	70	Tuff, >1% Pyrite, grey, crystal rich, brown clay rich matrix	moist	3.57	3,270	8.5				
70	75	grey welded Tuff, Tuff breccia, boulder +/- 3' dia., minor Pyrite	dry	3.88	3,460	4.3				
75	80	Reddish grey tuff, >1% pyrite, epidote, large blocks, light brown matrix	dry	4.23	3,660	5.9		X		
80	85	Red-grey tuff, >1% pyrite, epidote, large blocks, light brown matrix	dry	6.82	3,530	5.1				
85	90	Mixed volcanics, red-grey tuff, strong pyrite, oxidized and bleached crystal	dry	4.59	3,960	7.3	C9C			
90	95	Mixed volcanics, mostly rhyolite, red-grey, crystal rich, minor pyrite, light	dry	3.62	3,810	7.9				
95	100	Mixed volcanics, minor pyrite, light brown matrix	dry	3.42	3,330	5.9		X	X	
100	105	Mixed volcanics, mostly various tuffs, fresh, oxidized, light broen clay rich	dry	3.78	3,450	6.0				
105	110	Mixed volcanics, light brown-grey matrix	dry	3.73	4,660	5.6				
110	115	Tuff, light grey, crystal rich, boulder, light brown-grey matrix	dry	3.82	4,630	4.5		X		
115	120	Mixed volcanics, dominate tuff, light grey, boulder, grey matrix	dry	3.90	4,940	2.7				
120	125	Tuff, light grey, fresh, grey rock powder matrix	dry, bedrock	4.64	2,440	1.3				

Code:

C9A	Composite sample for grain size analysis
(light shading)	Sample for geochemical testing
(dark shading)	Bedrock as inferred from drill action and borehole samples

Appendix B

Physical Properties Log

Questa Waste Rock Investigation **Physical Properties Log**

Drill Hole: WRD-1
Logged By GM
Date 9/16/99

Interval From	To	Max Particle (inches)	Gravel (%)	Sand (%)	Silt and Clay (%)	Comments
0	5	1	60	20	20	Coarse gravel in fresh matrix, little weathering, durable
5	10	4	80	20		Very coarse gravel with +/- 20% sand and silt/caly
10	15	1.5-2	50	30	20	Increasing fines, fines NP
15	20	2-3	60	30	10	Coarse gravel
20	25	2..5-3	60	30	10	Similar to above, slightly coarser
25	30	3	50-60	30	+/-10	Coarse gravel with sand, durable, little weathering
30	35	2-2.5	50-60	+/-30	+/-10	Med coarse gravel with sand, NP fines
35	40					As above
40	45					As above
45	50	1.5-2	60	25	+/- 15	Slightly finer, mostly fine, durable gravel with slightly plastic fines
50	55	1.5	70	20	+/- 10	Mostly med gravel, fresh, dark with little weathering, durable
55	60	1-1.5	60-70	20-30	+/- 10	Mostly 1/4 to 1" gravel, little weathering, durable
60	65	1.5-2				As above
65	70	1.5-2				As above
70	75	3				As above
75	80	1-1.5	50-60	+/-30	+/- 10	Med coarse gravel, fresh and unweathered
80	85					As above
85	90					As above
90	95	1..5-2	70	20	+/- 10	Similar to above, coarser
95	100	2	70	20	+/- 10	Mostly 1" gravel, fresh and durable

Questa Waste Rock Investigation						Physical Properties Log
		Drill Hole:	WRD-2			
		Logged By	GM			
		Date	9/16/99			
Interval From	To	Max Particle (inches)	Gravel (%)	Sand (%)	Silt and Clay (%)	Comments
0	5	1	40-50	20-30	>20	Mostly fine gravel with weathered plastic fines
5	10					As above
10	15					As above
15	20	1.5	50-60			Slightly coarser, mostly - 3/4" gravel
20	25	3/4-1	30-40	+/- 40	+/- 30	Finer, mostly -3/8 " gravel and sand with plastic fines
25	30					As above
30	35					As above
35	40	1.5	30-40	+/- 40	+/- 30	As above, more coarse fragments
40	45	1				As above
45	50	1.5-2	40-50	20-30	+/- 20	Slightly larger gravel fragments, plastic fines
50	55	1.5				As above
55	60	1				As above
60	65	3.5-4	80	15	5	Mostly very coarse and durable, fresh and unweathered
65	70	3x5	60-70	20	10	Mostly 0.25 to 1" gravel

Questa Waste Rock Investigation — Physical Properties Log

Drill Hole: WRD-3
Logged By GM
Date 9/17/99

Interval From	To	Max Particle (inches)	Gravel (%)	Sand (%)	Silt and Clay (%)	Comments
0	5	3/4-1	+/- 50	35	15	-1/2 " gravel
5	10	2	100	0	0	Coarse and angular -2" gravel,. (Sample fines may have been lost)
10	15	1.5	80	15	5	Mostly -1" gravel, durable with few fines
15	20	2				As above
20	25	1.5	70	20	10	As above
25	30	1.5	+/- 50	40	10	-3/4" gravel, slightly plastic fines
30	35	2.5 x 3	60-70	35	10	Coarse -1.5" gravel, durable
35	40	2.5	70	20	10	Mostly -3/4" gravel with plastic fines
40	45	1.5	80	15	5	Coarse and durable -1" gravel , few large fragments, NP fines
45	50	2				As above
50	55	2.5				As above
55	60	2	60	30	10	Decreasing grain size, mostly -3/8" gravel, increasing altered fines
60	65	1/2	60	30	10	As above
65	70	3/4	20-30	50	30	Mostly fine sand and finer, slightly plastic
70	75	>4	55	30	15	-1" gravel in altered fines matrix
75	80	1.5				As above
80	85	2.5				As above
85	90	2	70	20	10	Mostly -3/4" gravel, altered matrix
90	95	1				As above
95	100	1.5	60	25	15	As above
100	105	1	50	30	20	Mostly -1/2" gravel
105	110	2	60	25	15	As above
110	115	2 x 3	75	20	5	More durable gravel, mostly -1", fresher fines
115	120	2	75	20	5	As above

Questa Waste Rock Investigation							Physical Properties Log
		Drill Hole:	WRD-4				
		Logged By	GM				
		Date	9/16/99				
Interval From	To	Max Particle (inches)	Gravel (%)	Sand (%)	Silt and Clay (%)	Comments	
0	5	1-1.5	70-80	+/- 20	+/- 10	Mostly >3/8 inch gravel, moderate weathering/alteration, durable	
5	10	1.5				As above	
10	15	1-1.5	70-80	+/- 20	+/- 10	Mostly >1/4 inch gravel with minor sand and fines	
15	20	1.5	+/- 60	30	+/- 10	Increasing sand and silt, some plasticity	
20	25	1.5	70-75	15	+/- 10	Mostly > 1/4" gravel	
25	30	3	+/- 60	20-30	+/- 10-20	Mostly gravel, several large fragments	
30	35	1	50-60	20-30	15-20	Increasing fines, more weathered/altered	
35	40	2	40-50	30	+/- 20	Few large fragments, mostly fine gravel and sand, weatherd/altered	
40	45	2.5	50-60	20-30	20	Well graded gravel, mostly fine gravel with sand, weathere/altered.	
45	50	3	60	30	+/- 20	Mostly coarse gravel weathered	
50	55	1-1.5	50	35	15	Finer gravel finer overall, weathered/altered.	
55	60	1-1.5	+/- 60	30	10-15	Coarser, mostly gravel	
60	65	2	50	25	25	Mostly gravel in weathered matrix	
65	70	1.5	50	25	25	As above	

Questa Waste Rock Investigation **Physical Properties Log**

Drill Hole: WRD-5
Logged By GM
Date 9/16/99

Interval From	To	Max Particle (inches)	Gravel (%)	Sand (%)	Silt and Clay (%)	Comments
0	5	1.5	50	30	30	Mostly fine gravel and sand in clayey matrix
5	10	1	50	30	20	Mostly -3/4" gravel, clayey altered matrix with mod plasticity, durable fragments
10	15	3/4-1	+/- 50			Mostly fine gravel and sand in clayey matrix
15	20	1.5	50	30	20	-3/4" gravel in plastic matrix
20	25	1	+/- 70	15	15	Slightly coarser
25	30	1	+/- 70	20	10	-3/4 inch gravel, slightly plastic fines
30	35	1.5	+/- 60	25	15	more durable gravel
35	40	3	70	15	15	Mostly durable gravel with some fines and sand,
40	45	1.5	+/- 50	40	10	Durable gravel
45	50	1.5	40	45	20	-1" gravel in fresh matrix, sandy
50	55	1.5	40	50	10	less gravel, mostly sand
55	60	1.5-2	60-70	20-30	10	Coarse durable fragments
60	65	1	50	30	20	Earthy, -1" gravel, NP fines
65	70	1.5				As above
70	75	3	+/- 70	20	10	Mostly fine gravel and sand, durable
75	80	2	55	30	15	Mostly gravel and sand, durable

Questa Waste Rock Investigation **Physical Properties Log**

Drill Hole: WRD-6
Logged By GM
Date 9/16/99

Interval From	To	Max Particle (inches)	Gravel (%)	Sand (%)	Silt and Clay (%)	Comments
0	5	1.5-2	30-40	35	20-25	Mostly -1/2' gravel in altered, high plasticity matrix
5	10	2				As above
10	15	1				As above
15	20	1				As above
20	25	1				As above
25	30	1.5-2	50	35	15	Mostly -1/2" gravel, mod plasticity matrix
30	35	2	50-60	30	15-20	Mostly -3/4 " gravel, altered matrix with mod plasticity
35	40	2				As above, mostly -1"
40	45	1.5				As above
45	50	2 x 3	70	20	10	Coarse gravel, durable and angular
50	55					As above
55	60					As above

Questa Waste Rock Investigation — Physical Properties Log

Drill Hole: WRD-7
Logged By GM
Date 9/16/99

Interval From	To	Max Particle (inches)	Gravel (%)	Sand (%)	Silt and Clay (%)	Comments
0	5	2	30	40	30	Mostly sand and fines, altered matrix with moderate plasticity
5	10	2-3	60	20	20	Few large fragments in weathered/altered matrix
10	15	1-1.5	60-70	20	10-20	Mostly fine gravel in weathered, clayey matrix
15	20	1.5	50-60	10-30	20-30	Mostly gravel in plastic clay matrix, moist
20	25	3/4	50	30	20	Finer, mostly fine gravel, plastic fines
25	30	1	70	20	10	Increasing gravel, more durable and less weathered/altered
30	35	2	50-60	20-30	10	Mostly -1/2" gravel, less altered
35	40	1/2-3/4	50-60	20	20	Mostly fine gravel and sand, increasing fines, slightly plastic
40	45	3/4	>50	20	10-20	Slightly plastic fines, few large fragments, mostly fine gravel, mod weathering/alt
45	50	3/4-1	+/- 50	30-40	+/- 10	Mostly fine gravel and sand, lower plasticity, mod weathering
50	55	>2 (one)	+/- 60	30	+/- 10-15	Coarse, more durable, mostly fine gravel and sand, less weathered
55	60	3/4-1	+/- 50	+/- 30	15-20	Increasing plastic fines, mostly fine gravel and sand
60	65	1-1.5	+/- 60	+/- 30	10-15	Slightly coarser gravel, plastic fines
65	70	1-2	40	30-35	15-20	More weathered, plastic fines, decreasing gravel content, mostly sand with gravel
70	75	1.5	50-60	+/- 30	10-15	Slightly coarser, gravel weathered.
75	80	3	60	30	10	Mostly coarse and durable gravel, 40% > 1"

Questa Waste Rock Investigation

Physical Properties Log

Drill Hole: WRD-8
Logged By GM
Date 9/16/99

Interval From	To	Max Particle (inches)	Gravel (%)	Sand (%)	Silt and Clay (%)	Comments
0	5	2 x 3	80	15	5	Mostly coarse gravel, weathered/altered matrix
5	10	1	40	45	15	Mostly fine gravel in weathered, altered plastic matrix
10	15	2	50	35	15	As above with more gravel, mostly -3/4" gravel
15	20	1	50	35	15	As above, mostly -3/8" gravel, few larger fragments
20	25	2	60	30	10	Mostly -3/4" gravel
25	30	2	50	35	10-15	Mostly -3/4" gravel in weathered plastic matrix
30	35	1				As above
35	40	1.5				As above
40	45	2.5				As above
45	50	3	60	30	10	-1.5" gravel, high plasticity altered matrix
50	55	1.5	60-65	25-30	15-20	-3/4" gravel, high plasticity altered matrix
55	60	1				As above
60	65	1				As above
65	70	2				As above, coarser - 1" gravel
70	75	2.5				Few larger fragments, -3/4" gravel
75	80	2				As above
80	85	2.5 x 3	70	20	10	Mostly minus 1.5" gravel